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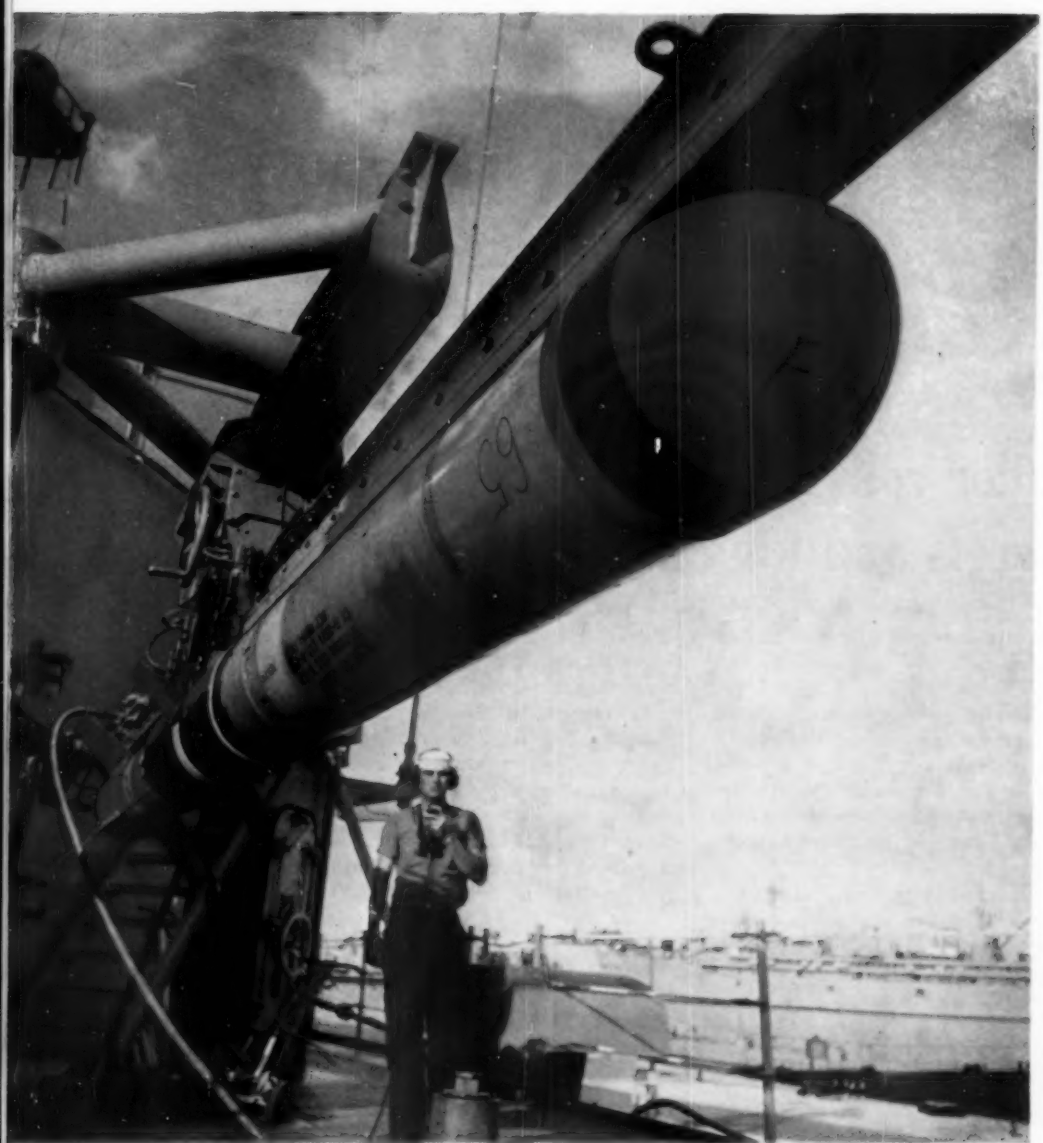
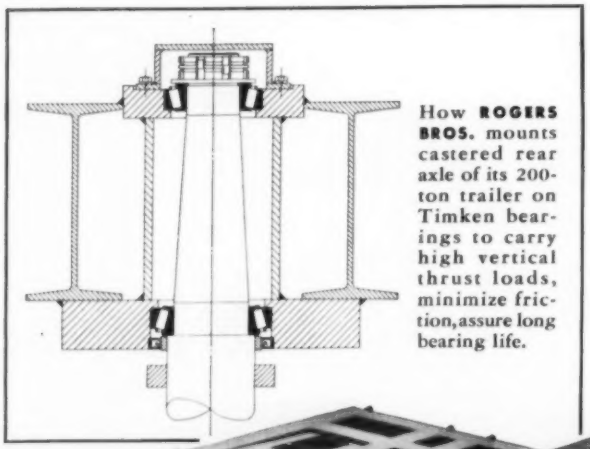


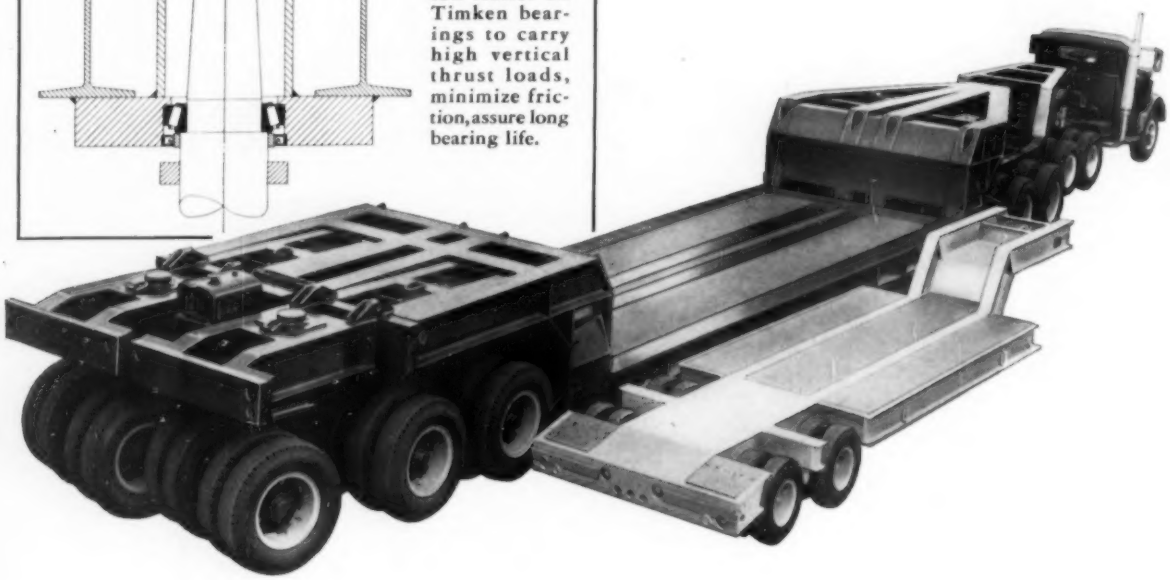
Asroc antisubmarine weapon

SEPTEMBER-OCTOBER 1960

EDITORIAL "THE TIMES DEMAND ALL-OUT PREPAREDNESS" . . . PAGE 217



How **ROGERS BROS.** mounts castered rear axle of its 200-ton trailer on Timken bearings to carry high vertical thrust loads, minimize friction, assure long bearing life.



Rogers trailer rolls 200 tons, tires track perfectly . . . with wheels and kingpins on Timken® bearings

It's a long 93 feet from truck bumper to end of trailer. And it has a huge 200-ton capacity—mounts forty—12 x 24—14 ply tires. You can see how this Rogers Bros. Corp. D-3-W200D trailer compares with its 25-ton "baby brother" model in the picture above. Big as it is, it rolls easily with 20 dual wheels on Timken® tapered roller bearings. Tires in the detachable, oscillating rear assemblies, track with the trailer—with Timken bearings providing a rigid but friction-free mounting for the vertical caster shafts.

Timken bearings are used because they . . .

1) *Practically eliminate friction.* Because Timken bearings have true rolling motion they roll smoothly, retain their precison longer.

2) *Assure maximum capacity, long bearing life.* The tapered design enables Timken bearings to take any combination of heavy radial and thrust loads. Full line contact between rollers and races gives *extra* load-carrying capacity. And special quality control in their manufacture further assures long bearing life.

When you build or buy a machine equipped with Timken bearings, you receive *extra* value. That's because of Timken Company leadership in tapered roller bearing design and manufacture. And Timken salesmen are graduate engineers trained to give you the finest technical bearing service available.

Advantages you buy with Timken bearings: *1) Quality you can take for granted. 2) Service you can't get anywhere else. 3) The best-known name in bearings. 4) The pace setter in lower bearing costs.* The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.* Canadian Division: Canadian Timken, St. Thomas, Ontario.

Industry rolls on

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tapered roller bearings

ORDNANCE

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Forty-one Years of Leadership in American Armament Preparedness

VOL. XLV | SEPTEMBER-OCTOBER 1960 | NO. 242

The Cover.—*The Asroc is the Navy's latest operational antisubmarine weapon. Fired from a ship's deck it first travels through the air like a rocket, plunges into the sea when nearing the target, and then travels underwater either as a homing torpedo or an atomic depth charge.*

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ON THE

THE CONTENTS OF THIS ISSUE IN BRIEF

To Defeat the Submarine (p. 188) . . . . "Oh where, oh where can they be?" might well be the song of the sailor today, for one of the most important problems is how to track down the elusive submarine. Rear Adm. P. D. Gallery, retired naval officer, points out the importance of submarine detection for national survival.

The New M60 Tank (p. 193) . . . . This powerful combat vehicle, armed with a British-designed high-velocity gun and powered by a 12-cylinder diesel engine, is a notable improvement over previous models, but even more advanced designs will be forthcoming, according to Mark S. Watson, noted military correspondent of the Baltimore *Sun*.

Rockets for Space Power (p. 197) . . . . To develop in haste and fix at leisure is not the creed of the National Aeronautics and Space Administration, according to its Director of Launch Vehicle Programs, Maj. Gen. Don R. Ostrander, U.S.A.F. However, technological competition is not the greatest concern but rather the development of space vehicles as rapidly as possible without losing reliability.

The Disarmament Myth (p. 201) . . . . The Communists throw up a smoke screen of double talk and double thinking to lull the rest of the world into the belief that they will go along with the total disarmament proposal. This, according to famed British author Maj. Reginald Hargreaves, is really an elaborate façade behind which the Red Army, camouflaged as paramilitary police, would actually be a full-fledged battle-ready force capable of striking at any of its disarmed and helpless neighbors.

General of the Armies John J. Pershing (p. 205) . . . . One hundred years after the birth of this great American soldier it is fitting that we take a look at his life and works and learn to apply something of his courage and organizational genius to our present problems.

Airlift—The Weak Link (p. 206) . . . . The Achilles' heel of our defense structure could be the inadequacy of our airlift. The aircraft that MATS employs today is outmoded. In addition, there are only thirty-nine really modern planes in the whole MATS fleet. Lieut. Gen. Ira C. Eaker, U.S.A.F. (Ret.), tells of the serious implications of the airlift shortage as viewed by Congress during recent hearings.

Make Weapons Simple (p. 209) . . . . Human engineering is the key to acquiring durability, reliability, ease of maintenance, and reduction of costs, according

to Maj. Gen. Louis V. Hightower, U.S.A., Office of the Director of Defense Research and Engineering, Weapons Systems Evaluation Group. Both designer and producer must consider this through all phases of equipment development. Decrease in training requirements by simplicity of design will help to compensate for loss of build-up time should hostilities begin.

Artillery Forward! (p. 212) . . . . A vivid picture of men and weapons as they fought some of the most rugged battles of the Civil War is drawn by Fairfax Downey, famous author and historian. Here is a moving account of the days when the howitzer came into its own as a weapon that could seek out sheltered spaces which direct fire could not hit and when field-gun trails were elevated or depressed to help find the target amid mountainous terrain.

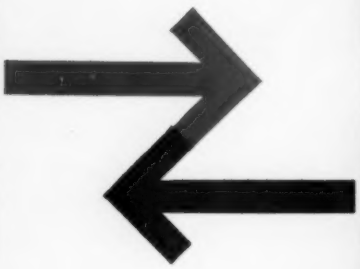
Our New Missile Strength (p. 285) . . . . Our ballistic missiles are dependent upon the reliability of ground-support equipment, which makes up eighty per cent of the total missile system. "Beating the clock" is significant in extending our defense capabilities, Col. W. D. Alexander, U.S.A.F., Headquarters, Air Force Ballistic Missile Division, Los Angeles, Calif., tells his readers. We have done well, so far, for in only six years we have combined reliability and versatility in our ballistic missiles. This and the two following articles are based on addresses delivered at the Forty-second Annual Meeting of the A.O.A. held at Cincinnati and Wright-Patterson Air Force Base, Ohio.

Air Force Procurement (p. 289) . . . . How the Air Matériel Command plays its role as official "buyer" for the Air Force is described by Brig. Gen. W. R. Graalman, U.S.A.F., Deputy for Procurement, AMC, Wright-Patterson Air Force Base, Ohio. The AMC supports the Air Force in its endeavors and at the same time assumes the responsibility of answering to the taxpayer for expenditure of funds.

Aerospace Research (p. 292) . . . . A new type of war faces us today. Instead of using spears, cannon, or bombs, we are fighting a technological war which requires a breath-taking speed-up of scientific research. Col. Carlo Tosti, Air Research and Development Command, Andrews AFB, Washington, D. C., stresses the importance of compressing the research period and cutting down lead time and points out how these things can be accomplished.

Soviet Metrology (p. 296) . . . . What is the U.S.S.R. doing in the fields of standards and metrology? This translation of a Khrushchev speech outlines an enlarged and dynamic metrology program which ORDNANCE readers will recognize as an industrial-preparedness program on the other side of the Iron Curtain.

The elements of guidance and control:



Data Acquisition and Application Subsystems—IBM has proven capabilities to provide real-time man-to-machine and machine-to-machine elements of weapon guidance systems. In addition to the Bombing-Navigation system with its visual displays in the B-52, IBM also provides interface devices to apply this system to air-launched missile guidance. Federal Systems Division experience in air-based and ground-based guidance systems is proven in operation.

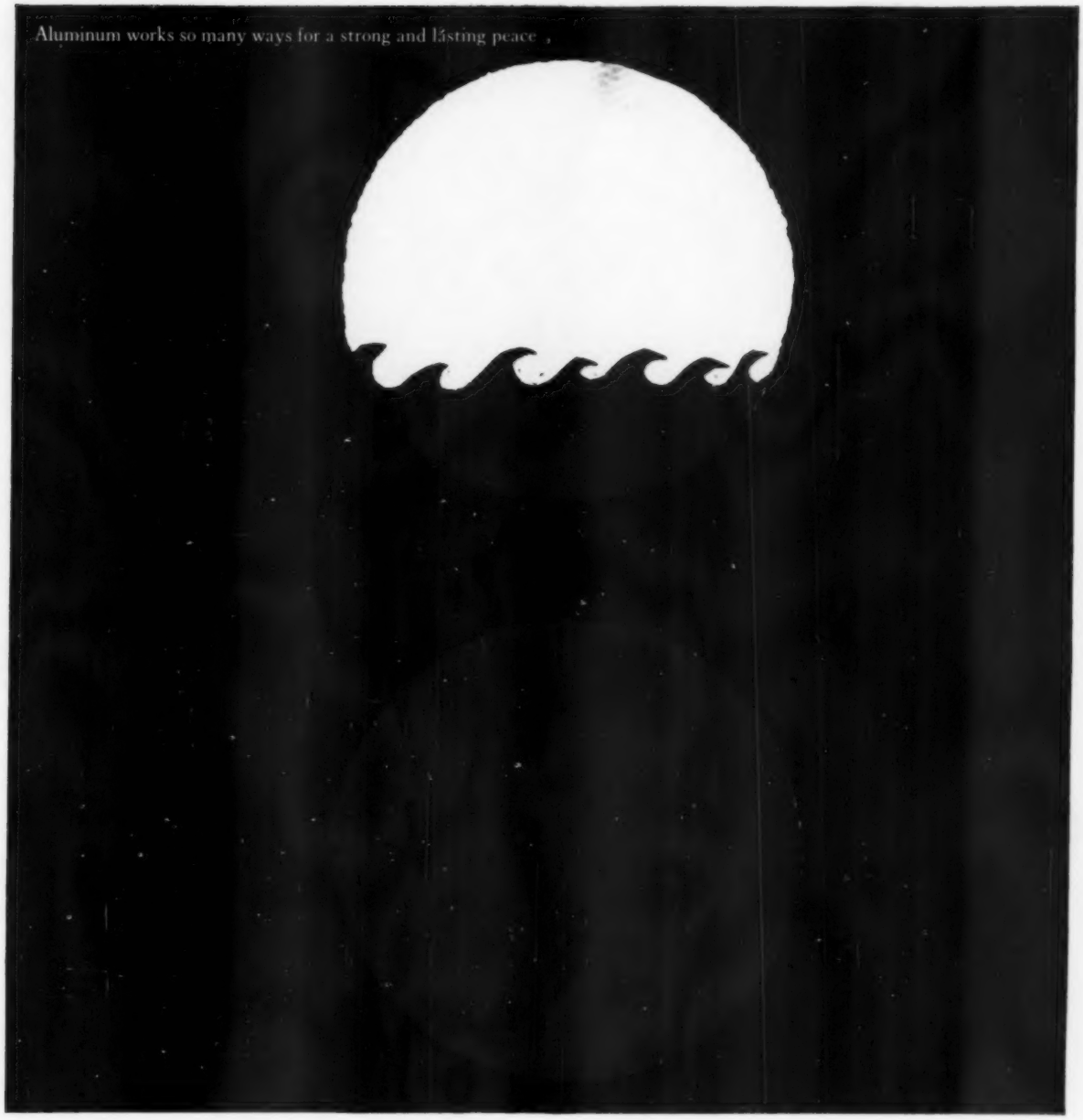
Data Communications Subsystems—The SAGE data processing system, heart of America's air defense network, embodies advanced communications devices and techniques required to filter and direct an enormous flow of data. Designed and built by the Federal Systems Division, the AN/FSQ-7, an advanced system in operation, embodies processing and communications power to direct defense operations as well as to guide missiles from remote sites.

Data Processing and Control Subsystems—Now in development, the Advanced Bombing-Navigation and Missile Guidance system is another example of IBM's "closed-loop" system capability. This system satisfies the operating requirements of high-speed, long-range weapon systems. Compact, reliable equipment such as this and Federal Systems Division's computer for the Titan missile guidance system are the result of IBM's vast background in data processing and control.

all systems capabilities of IBM

IBM's experience in data processing and data communications, supplemented by an extensive background in data acquisition, adds up to a three-way capability for developing, producing and integrating total automated systems. This capability is being advanced through continuing research in miniature high-speed devices for high-reliability guidance systems of the future.

Federal Systems Division, 326 East Montgomery Avenue, Rockville, Maryland **IBM**



Plumbing the Depths?

Alcoa goes to work immediately on defense projects

Aluminum is corrosion resistant in steam, high-purity water or salt water. That's why this water-compatible metal holds such promise in marine applications, as in atomic subs and cruisers, for example. Alcoa even anticipated the day when water would be the cooling medium for reactors that generate temperatures ranging from 500° and higher. We now have several new aluminum alloys able to handle these higher heats. Ask yourself where you can use them. For more information, write Aluminum Company of America, 2031-J Alcoa Building, Pittsburgh 19, Pa.

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LOW-SHOCK TRACKED MOBILITY FOR SENSITIVE ELECTRONIC EQUIPMENT

The tactical advantages of full off-road *tracked* mobility in military support vehicles have been well proved in many years of field operation. But the idea of transporting intricate radar and communications equipment and fully-assembled missiles over rugged terrain raises the question, "What about vibration and shock input to sensitive components?"

The answer – favorable. Carrying a simulated missile and sensitive oscillograph recording equipment, an FMC tracked vehicle ran a 2,000-mile shock test over our proving ground – on 60° slopes, over rough cross country terrain, and on high speed roads. Data returns showed that the vehicle's torsion suspension system effectively cradled the missile, with a low shock input factor.

For full details on these tests and other questions of adapting tracked mobility for your purposes, contact FMC, America's leading producer of military-standardized tracked vehicles.

For further information, write, wire or phone Preliminary Design Engineering Dept., FMC Ordnance Division, P.O. Box 367, San Jose, California. Phone: CYpress 4-8124.

Putting Ideas to Work

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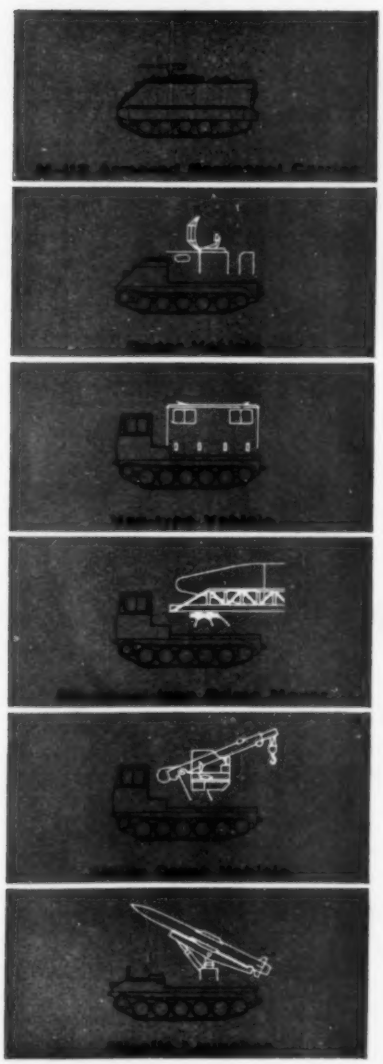
Illustrated below are the M-113 and five vehicle adaptations of this basic tracked vehicle. All of the vehicles use the same military standard equipment, including engines, power train, and suspension components; thus reducing the military logistic burden and R&D costs in weapons systems.



FMC's New Liquid Propellant Metering System Achieves Accuracy to ±0.1%

Mobile metering and control unit for fueling liquid propellant missiles.

The crucial reliability of multistage missiles is influenced by the accurate measurement and delivery of liquid propellant to the missile tanks. For example . . . a small error in fuel weight could adversely affect the in-flight performance of the missile, causing possible failure of the entire mission.

Food Machinery and Chemical Corporation's Ordnance Division has recently developed a mobile liquid propellant metering and handling system which promises to solve many missile fueling problems. The advantages offered by this unique new system are many.

Accurately measures and records the amount of fuel delivered to the missile tanks. Original specifications called for a metering accuracy of ±0.2%. Extensive tests, recorded by precision test equipment, show that the system is capable of metering and delivering missile propellants with far superior accuracy—to ±0.1%.

Automatically compensates for factors influencing fueling accuracy. The fuel is continuously sampled and the flow corrected for variations in temperature and density. In addition, the fuel which vaporizes in the missile tanks is returned to the system, condensed, measured, and an equivalent amount added by the metering unit.

Adaptable to many different missile fuels. The system is designed to handle such storable liquid propellants as hydrazine, nitrogen tetroxide, Dimazine® (UDMH) and nitric acid.

Economical to manufacture and safe to operate. To reduce development, manufacturing and operating costs, the system makes maximum use of standard, interchangeable, and commercially available components. The simple and safe design eliminates human errors and danger to operating personnel.

Mobile and compact. All metering, pumping and control equipment is mounted on a single, portable trailer. The complete unit may be easily transported, rapidly positioned, and provides a single station for the monitoring of fueling operations.

The successful development of this mobile metering and handling system by the engineering staff of FMC's Ordnance Division is another achievement made possible by utilizing the unique combination of chemical and mechanical engineering talent available at Food Machinery and Chemical Corporation.

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Burroughs Corporation Burroughs *"NEW DIMENSIONS / in computation for military systems"*

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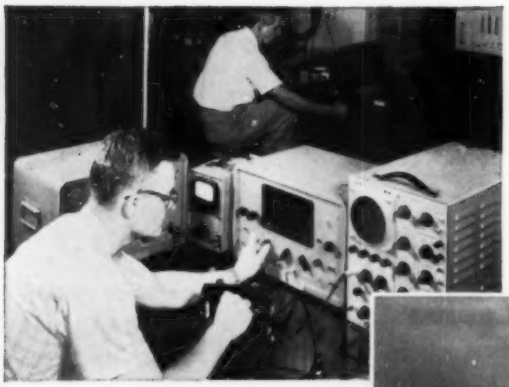

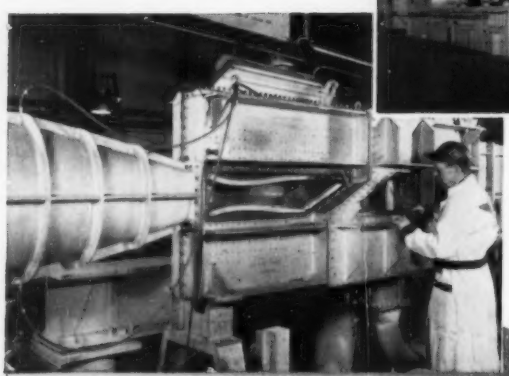

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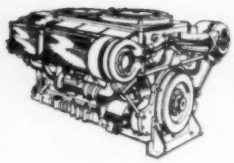

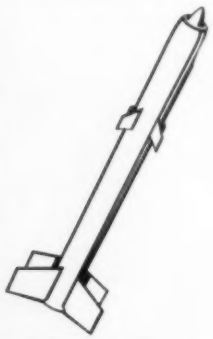

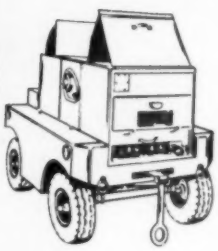

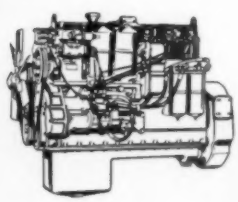

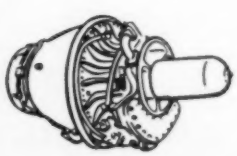

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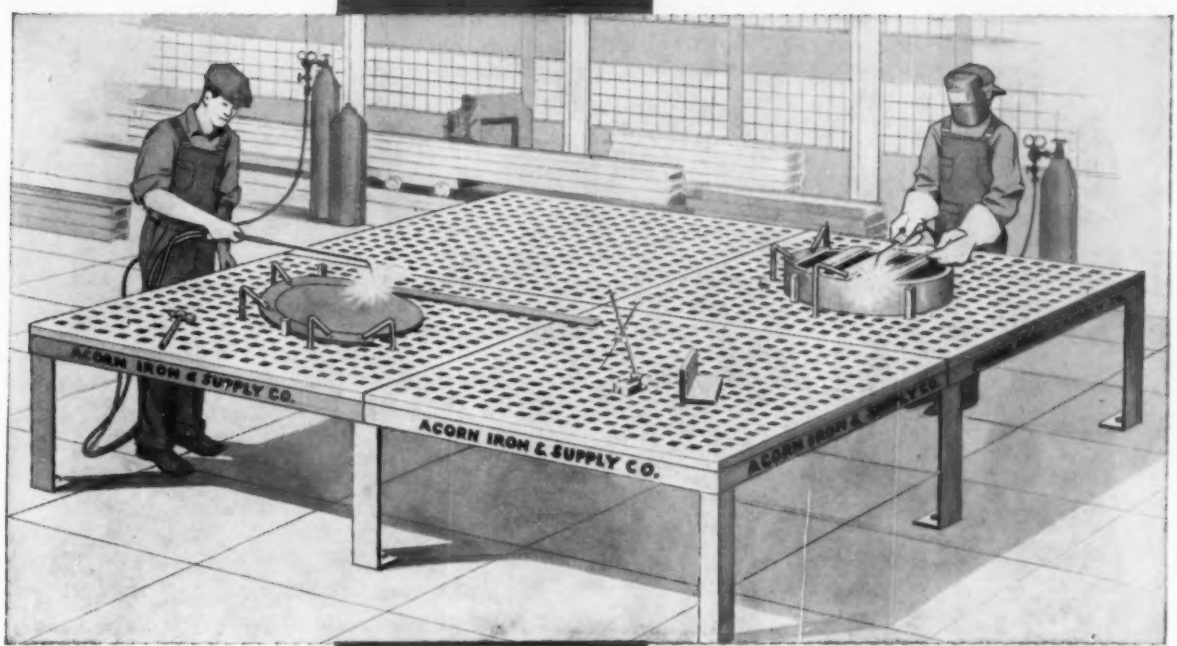

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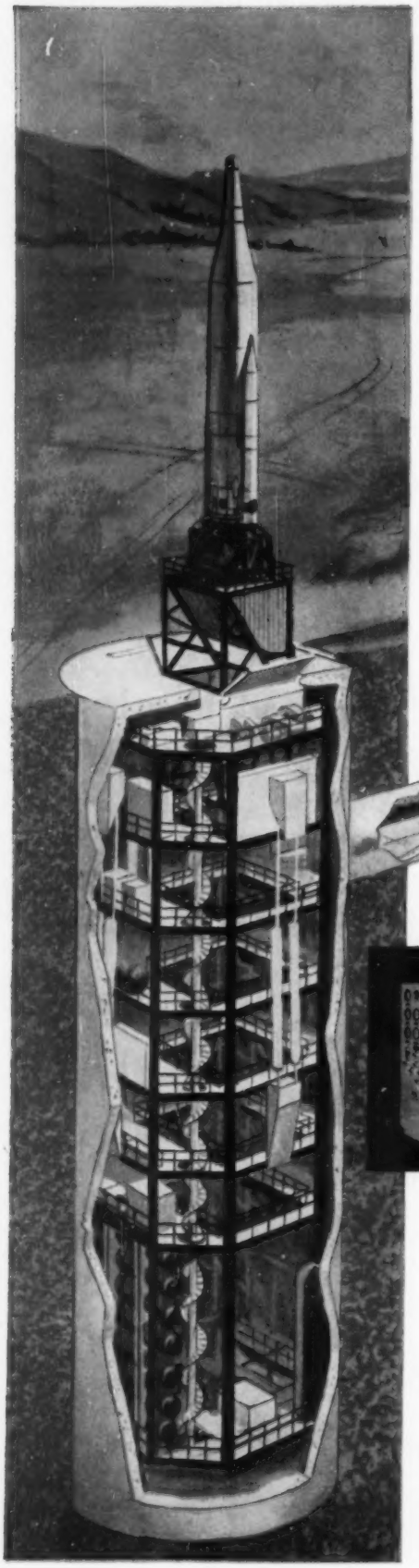
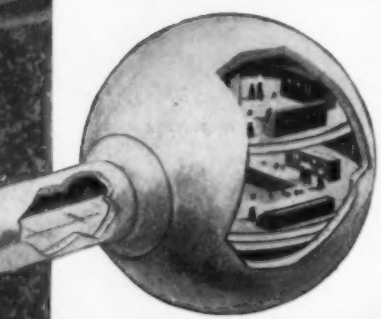
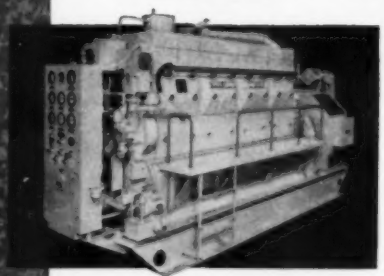


WHITE SUPERIOR ENGINES selected for ATLAS launching sites!

At USAF Atlas launching sites throughout the United States, prime and standby power will be supplied by White Superior engines! The Army Corps of Engineers, Kansas City, Missouri, has purchased 149 eight-cylinder supercharged Model 40 Superiors, each driving a 500 KW generator. These engine-generator sets will produce precise frequency for operation of computers and other electronic equipment. Six of the 13 planned Atlas ICBM squadrons will feature underground silo-type launching sites. Here an additional task for the Superiors will be powering elevator machinery to lift the 120-ton ICBM's to ground level, after they have been fueled and checked out down under.





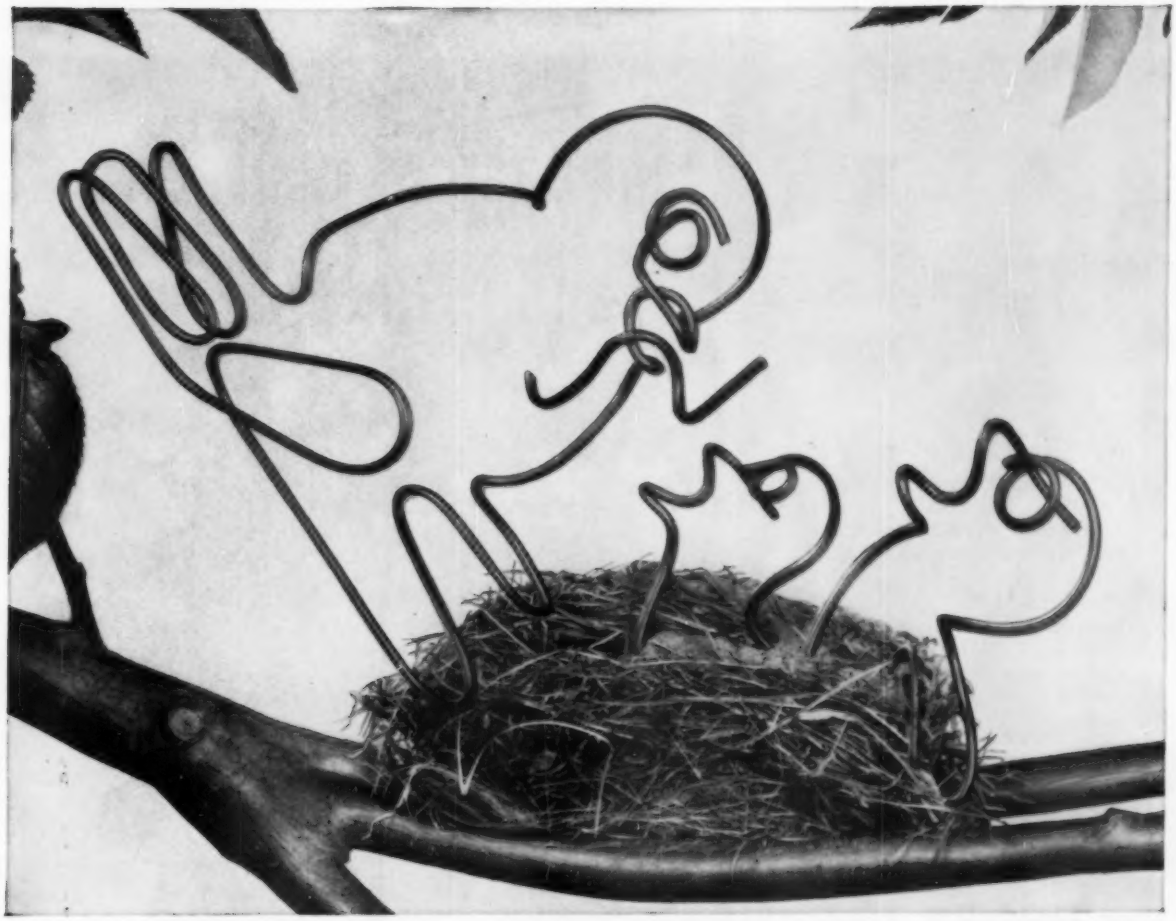
White Diesel

Superior ENGINES ATLAS Imperial DIESEL ENGINES White DIESEL

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY
Plant and General Offices: Springfield, Ohio

The contract for 149 Superiors highlights a growing and impressive list of Superior-powered U.S. defense installations. Included are the "Texas Towers," portions of "DEW" line and "SAGE" project, Eglin Gulf Test Range and other missile tracking ranges, and numerous launching sites for other types of missiles. Acceptance of Superior engines for these assignments is convincing evidence of their rugged dependability, trouble-free performance and economical fuel consumption. Superior engines—215 to 2150 HP or 150 to 1500 KW—will also meet your exact power requirements, including automatic, unattended or remote controlled operation. Write for complete information today!

USAF artist's conception of Atlas underground silo for launching missiles



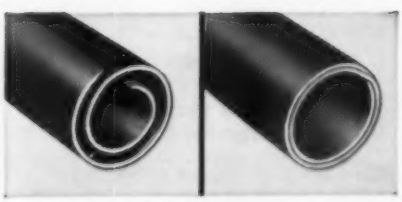
Bundy can mass-fabricate practically anything

. . . with Bundyweld® — double-walled steel tubing that is adaptable to a whole host of applications.

WHATEVER your tubing problems, the Bundy man awaits your call. That's because tubing problems are Bundy's business, and Bundy engineers — with years of tubing experience — can often come up with a design angle that'll save you time and money.

But the Bundy service doesn't end there! Specially designed Bundy machines take over the mass-fabrication of these parts in unlimited quantity. And to meet rigid specifications, we use Bundyweld — the original double-walled steel tubing—the safety standard in small diameter tubing. Thinner-walled Bundyweld is stronger and gives you higher bursting and fatigue strengths. Meets ASTM-254 and Government Spec. MIL-T-3520, Type III.

Why not bring your tubing troubles to Bundy? See Sweet's Product Design File 1e/Bu . . . or write Bundy Tubing Company, Detroit 14, Michigan.



Bundyweld is the original tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

There's no substitute for the original Bundyweld Tubing.

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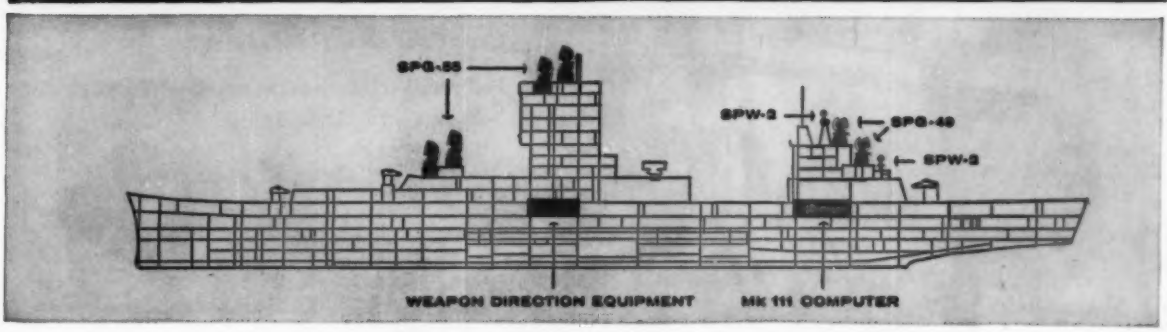
...aboard the Navy's first nuclear-powered cruiser, the Long Beach



Fire Control by SPERRY

When the Navy's first nuclear-powered surface ship—the USS LONG BEACH—joins the fleet, she will have a cruise capability of better than 30 knots, with virtually unlimited range, and she will be armed with the surface-to-air Talos and Terrier missiles. The most advanced ship of her kind, the "CGN-9" will have the most advanced shipboard missile control equipment: Sperry.

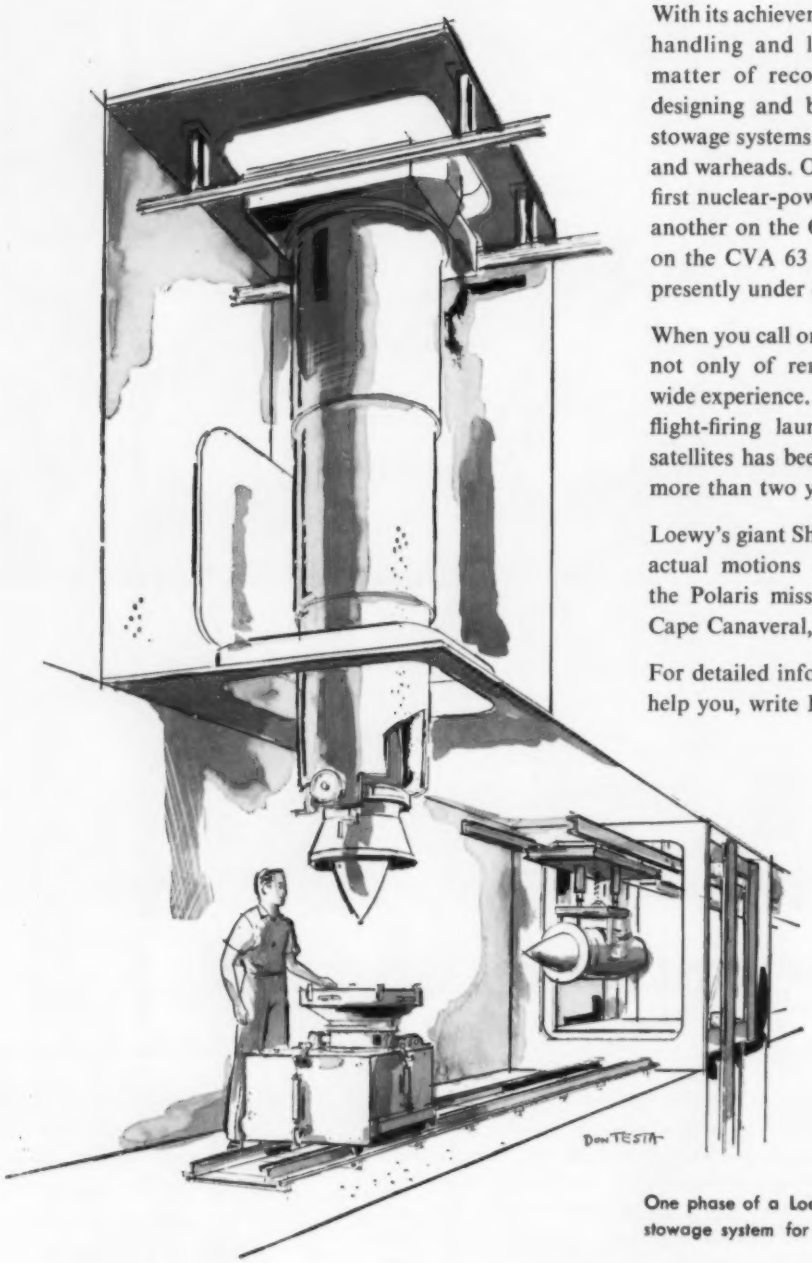
Forward, Sperry SPG-55 missile-guidance radar directs the Terrier missile. Aft, Sperry SPG-49 super-radar controls the longer range Talos missile. Amidships, and in the protected below deck region, are the brains of the systems, the computer complex. The Sperry Weapon Direction Equipment (WDE) evaluates target threat and decides which missile to fire at the selected target. The Sperry Mk 111 computer reads target position data from the SPG-49, calculates the best missile-to-target flight path, and positions the guidance beam generated by the Sperry SPW-2 Radar. Then it evaluates "kills."

With her combination of speed, range, firepower, and advanced Sperry fire control and navigation equipment, the LONG BEACH will make a formidable argument for peace when she joins the fleet.

SPERRY

SURFACE ARMAMENT DIVISION, SPERRY GYROSCOPE COMPANY, DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, NEW YORK

For Terrier and Talos missiles and warheads . . . new shipboard handling and stowage systems by Loewy



One phase of a Loewy handling, mating and stowage system for warheads on shipboard.

With its achievements in missile and rocket ground handling and launching equipment already a matter of record, Loewy-Hydropress is now designing and building shipboard handling and stowage systems for the Terrier and Talos missiles and warheads. One system is to be installed on the first nuclear-powered cruiser, U.S.S. *Long Beach;* another on the CG 10 Class cruisers; and a third on the CVA 63 Class aircraft carriers, which are presently under construction.

When you call on Loewy, you are availing yourself not only of remarkable ingenuity, but also of wide experience. The Loewy system for testing and flight-firing launching vehicles of earth-circling satellites has been functioning without failure for more than two years.

Loewy's giant Shaker installation, which simulates actual motions of seagoing ships for test-firing the Polaris missile, is in successful operation at Cape Canaveral, Florida.

For detailed information on how we can possibly help you, write Dept. H-9.

BALDWIN · LIMA · HAMILTON

Loewy-Hydropress Division • 111 Fifth Avenue, New York 3, N.Y.

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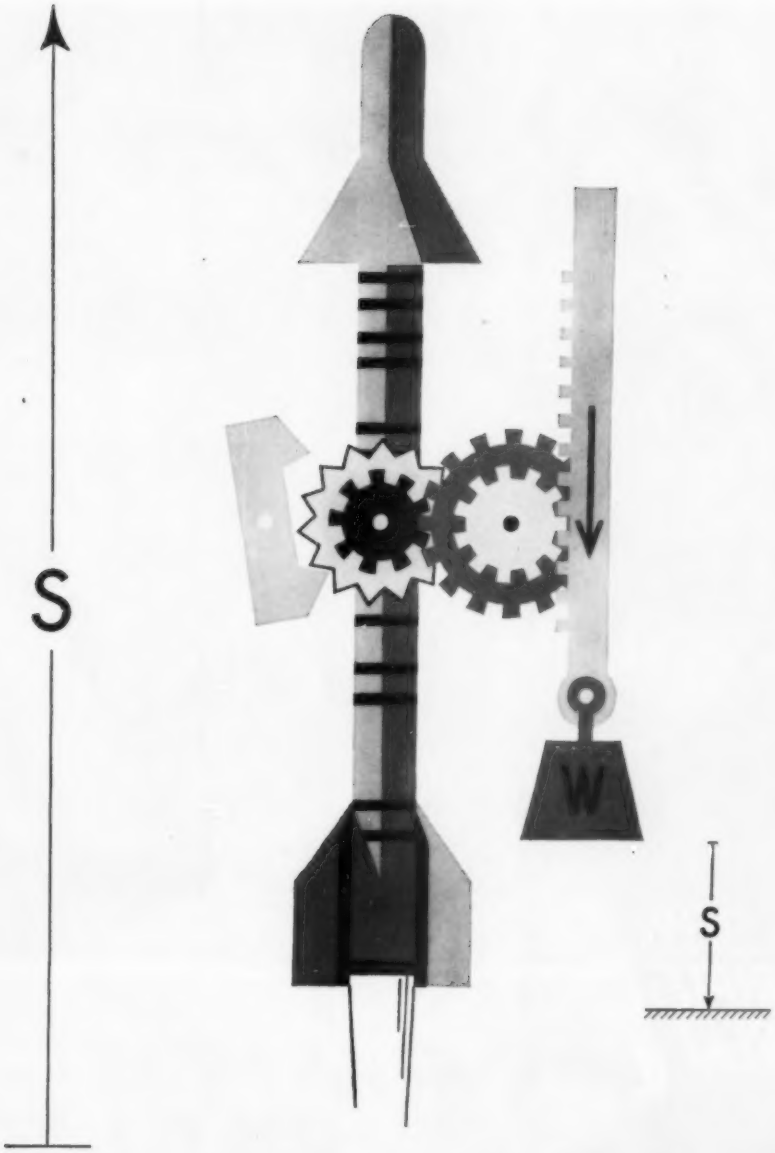

Bulova escapement used as an integrating accelerometer

Bulova's unusually creative teams of scientists and engineers play an ever increasing role in the vanguard of precision design and development. Consider the nature of a Bulova escapement; it's generally employed as a second-order integrating accelerometer. However, the basic mechanism lends itself equally well to rotational motion of unbalanced rotors in an accelerating field.

The drawing above shows an inertial element, or weight, coupled to a runaway escapement by a rack. A safe-arm latch locks the system until missile launch. Under acceleration the escapement will delay the weight from moving through its stroke, s, according to the following:

$$(1.) \qquad t = \sqrt{\frac{K}{ag}}$$

Where t is the time for the weight, W, to traverse its stroke, s, under an acceleration a, K is the mechanism constant which takes into account the gear ratio; the moment of inertia of the system as reflected at the pallet wheel; and the number of pallet cycles involved during stroke s.

If the acceleration is constant, the change in distance of the missile during t is

$$S = \frac{1}{2} agt^2$$

or

$$(2.) \qquad t = \sqrt{\frac{2S}{ag}}$$

Equating (1) and (2)

$$\sqrt{\frac{2S}{ag}} = \sqrt{\frac{K}{ag}} \qquad S = 2K$$

It is thus evident that, for a given escapement with a given stroke, the distance integrated is constant, and is independent of acceleration.

Bulova developments in the field of time measurement are particularly significant because they advance the state-of-the-art with existing systems and elements . . . with existing components of proven reliability and accuracy. But, continuing study of new concepts keeps Bulova systems years ahead—ready to meet the future needs of both the military and industry.

BULOVA

Research & Development Laboratories, Inc.
62-10 Woodside Avenue, Woodside 77, N. Y.

NEW TRIPLE-THREAT MOBILITY...

...and it runs in a family!

Today the Army is testing prototypes for a completely new "family" of medium duty, rubber-tired, multi-wheel drive vehicles. Vehicles that will be light enough to be transported by air, tough enough to take a parachute drop and travel roughest terrain, versatile enough to either speed along a highway or float across a river.

Competitive designs for these amazing new vehicles have been submitted by three major automotive manufacturers and each builder's ideas differed widely from the others in basic concept. So different, in fact, that each design demands entirely different types of driving axles and components. It is no wonder then, because of Rockwell-Standard's 50 years of experience in supplying the military with the industry's most complete line of driving assemblies, that each of the three competitive manufacturers consulted with our engineers on the power transmission problems. As a result . . . *all three prototypes are equipped with Rockwell-Standard® Axles.*

If you are a designer or builder of military vehicles and confronted with a problem involving driving assemblies, be sure to consult with Rockwell-Standard. Our experience, facilities and complete line of axle components will save you valuable time and help insure the dependability of your finished vehicle.

Products of... **ROCKWELL-STANDARD CORPORATION**

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computers that pace man's expanding mind

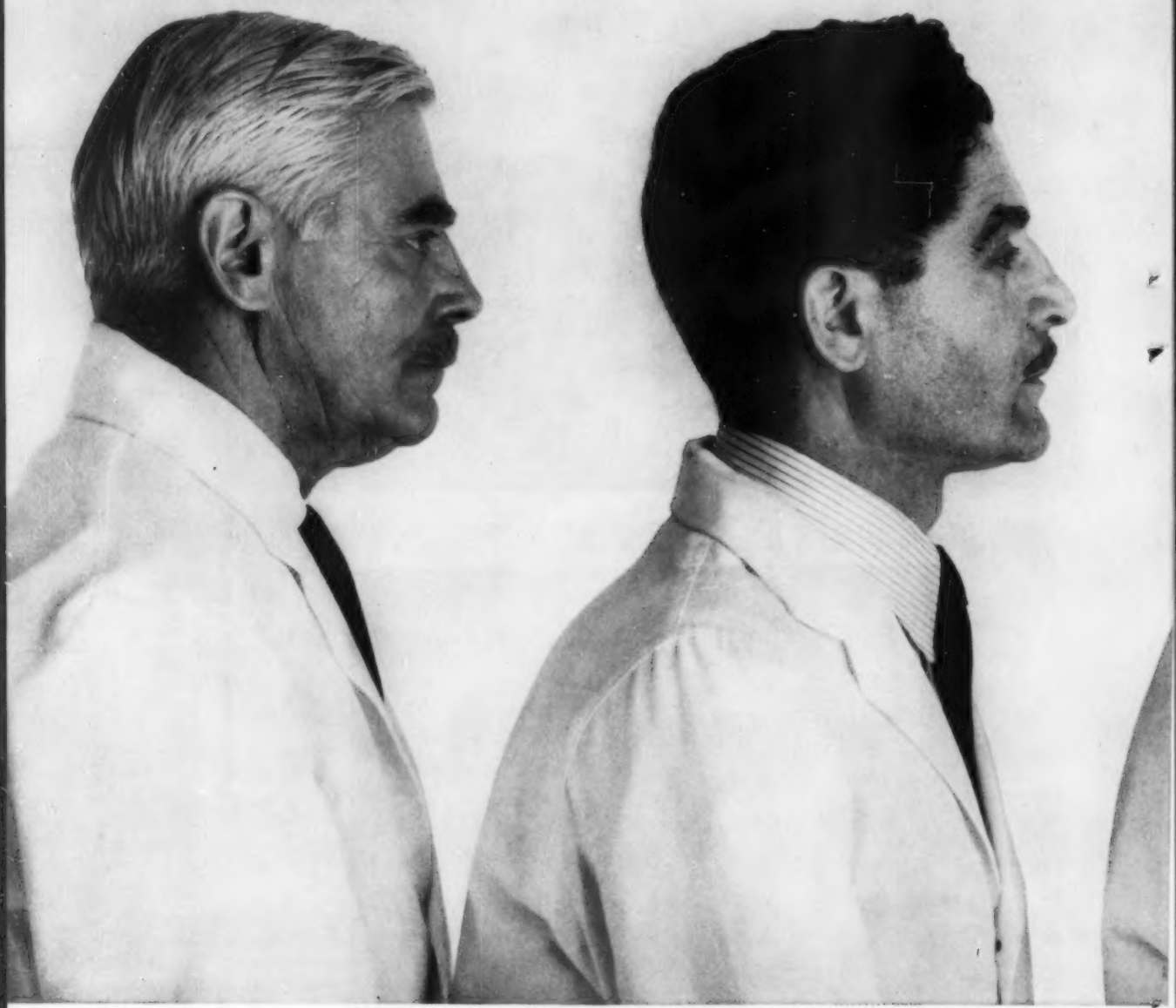
GP LI-09

"Mein Herr, jawohl, durch...

$$\psi(x) = \frac{1}{\sigma(2\pi)^{1/2}} \exp\left(-\frac{1}{2}\frac{x^2}{\sigma^2}\right)\ldots$$"

"El próximo año

$$P = \frac{A}{A\text{-}B}E_{N,A} - \frac{B}{A\text{-}B}E_{N,B}\ldots$$"



7200 idea-exchangers in

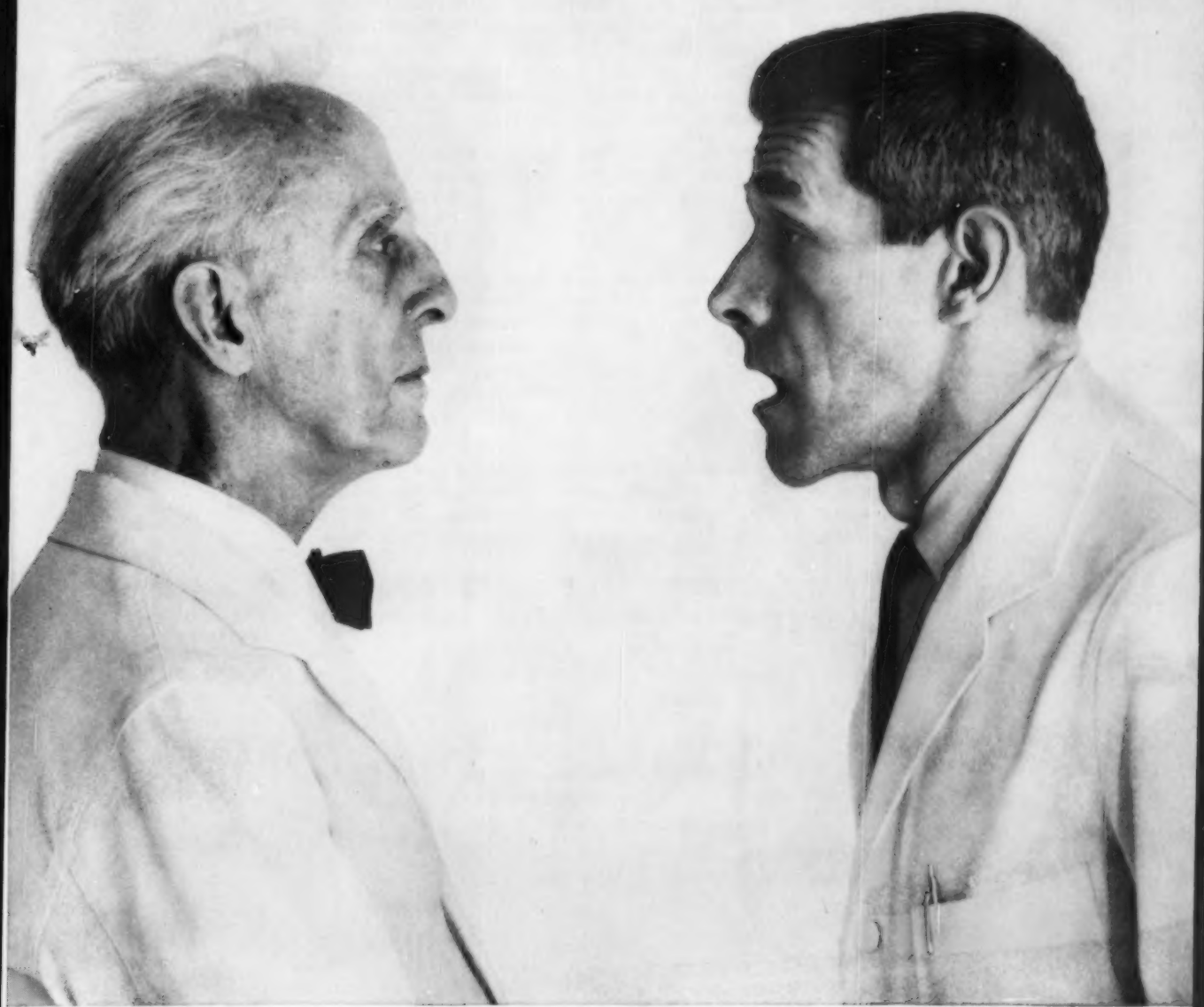
Each of ITT's 101 plants and laboratories (a total of 136,000 employes) is, by the nature of ITT's farflung organization, a meeting place for the scientific minds of the world. Ideas pour in, rub shoulders, take off, result in: a fully automated post office in Providence, R. I. ... a multiplier tube that detected water vapor on Venus... a

RESEARCH & DEVELOPMENT / ELECTRONIC EQUIPMENTS / AIR & MARINE NAVIGATION / ELECTRONIC COMPONENTS / MILITARY-SPACE ELECTRONICS /

"S'il vous plaît...

$$H(x)=\sum_{i}^{n} p_i \log \frac{1}{p_i} = -\sum_{i}^{n} p_i \log p_i \ldots"$$

"Thank you, gentlemen.
Your experience in
your countries has been
of infinite value to us.
In a few years, I think fully
automated post offices are going
to be as American as apple π."



24 countries work for ITT.

satellite system that could make worldwide TV a matter of a few years. As a signal can be bounced from one planet to another, so can an idea grow in bouncing from one mind to another. International Telephone and Telegraph Corporation, 67 Broad Street, New York 4, N. Y.

ITT

COMMUNICATIONS SYSTEMS / ELECTRON TUBES / DATA PROCESSING / AUTOMATION SYSTEMS / SYSTEM MANAGEMENT / COMPLETE FIELD SERVICES

15 THOUSANDTHS OF A SECOND IS A VERY LONG TIME

It's much faster than you can wink an eye, yet time enough for Bell Laboratories' new high-speed switching terminal to transfer your voice to another channel while you are talking by telephone.

The new terminal—recently introduced on the transatlantic cable—uses the idle time in the conversations of talkers on a group of channels to provide paths for other talkers. This time-sharing technique, called Time Assignment Speech Interpolation, permits the sending of 72 simultaneous phone conversations over this deep-sea system where only 36 could be sent before.

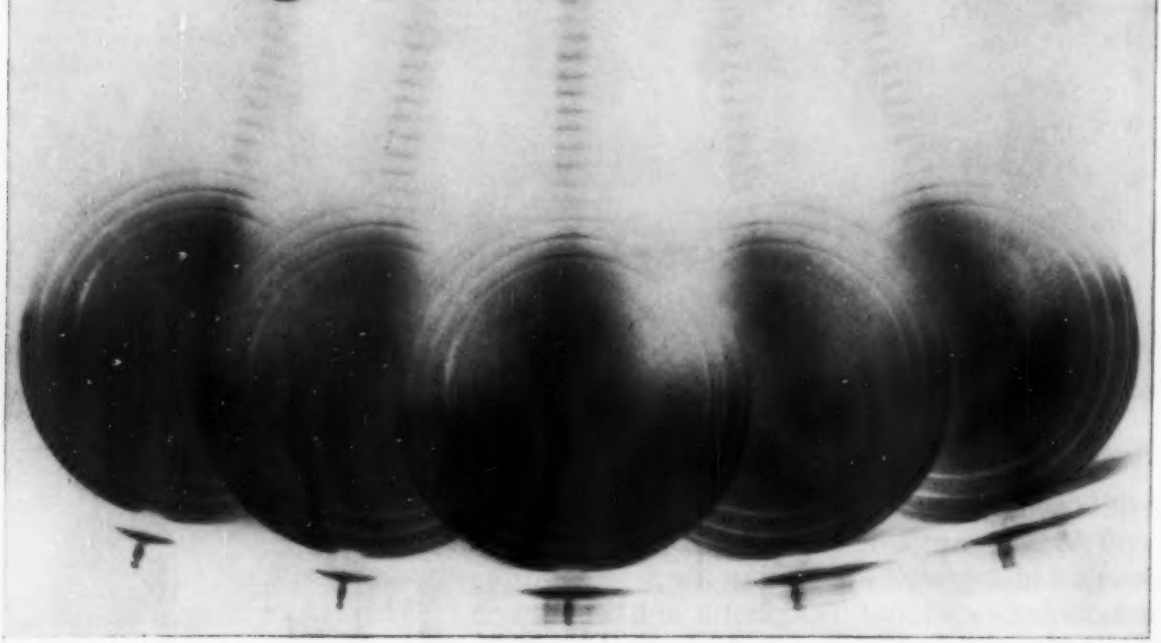
TASI takes advantage of the fact that in a normal telephone conversation you actually talk less than half the time. You do not talk when you are listening, and even when you do talk there are pauses between sentences, words, and syllables. When there are more talkers than channels, TASI puts this idle time to use.

Scanning each circuit thousands of times a second, TASI instantly notices when you aren't talking, then quickly switches in someone who *is*. TASI also notices when you resume talking, immediately finds a channel not in use that moment and switches you to it. Your voice may be switched many times during a single conversation in a time too fast—about 15 milliseconds—for your ear to perceive.

The TASI switching terminal was rendered feasible by the transistor—an invention of Bell Telephone Laboratories. More than 16,000 transistors are employed to achieve the compact, dependable, high-speed circuitry required. TASI is another example of how Bell Laboratories works to keep your telephone service the world's finest.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT



ATOMIC ENERGY

New Graphite Process

A new process which substantially reduces the time and cost of making molded graphite, used as a moderator in certain types of nuclear reactors, has been developed for the AEC by the Armour Research Foundation of the Illinois Institute of Technology.

In the conventional graphite-manufacturing process, a carbon-containing material such as petroleum coke is mixed with a "binder" such as coal-tar pitch. The mixture is molded and requires support while being heated to temperatures as high as 2,700 degrees Fahrenheit to burn out the noncarbon materials. After cooling, the resultant carbon is reheated to approximately 5,000 degrees Fahrenheit causing the carbon to crystallize into graphite.

In the Armour process, the carbonization and graphitization steps are combined into a single heating and cooling cycle. A synthetic binder, furfuryl alcohol is combined with petroleum coke and heated directly to the graphitization temperature without intermediate cooling. Carbonization takes place during the early stages of heating. This technique is possible because furfuryl alcohol is a thermosetting material which hardens when heated.

A body fabricated with this binder does not require support during the carbonizing phase as does a body utilizing conventional binders which tend to liquify at high temperatures. This eliminates the necessity for cooling down and removing the specimen following carbonization. The ARF single-cycle process cuts the time necessary for making laboratory graphite specimens of comparable size from nearly two weeks to approximately two hours.

Radioactivity Reports

Arrangements have been made for public reporting, on a regular basis, of radioactivity data collected in the vicinity of major AEC installations. The initial group of reports became available in July. Wider coverage and great uniformity in methods of presenting the data are expected as the program develops.

Quarterly and annual summary reports of environmental radioactivity data will be provided by the Commission's contractors to the AEC area or operations offices which will provide these reports and summaries to the Commission for transmittal to the U. S. Public Health Service. Copies of the reports also will be

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in 7 Distinct Grades

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SEE MILITARY DISPLAYS

Atomic Energy (Contd.)

made available to interested groups or individuals on request.

The data are produced from routine monitoring programs around Commission plants and laboratories where operations are of such nature that plant perimeter radioactivity monitoring surveys are required. This monitoring is done in order to check controls and determine the effect, if any, upon surrounding areas.

Neutron Irradiation

With industrial irradiation facilities becoming available, the Atomic Energy Commission has reaffirmed its policy of performing neutron irradiation services in Commission-owned facilities for commercial firms and private institutions only if privately owned facilities are not reasonably available for the services required. Similarly, foreign requirements for irradiations will be fulfilled by the Commission only if private sources are not reasonably available to do the work.

The action is in line with the Commission's general policy to reduce and eventually eliminate its sales and services in fields where industrial sources become reasonably available. Private facilities of varying degrees of capability are now available for commercial irradiations, and additional facilities are in prospect. For the most part, these facilities should be able to perform all desired commercial irradiations.

Neutron irradiation services from Commission facilities have been used by commercial concerns for radioisotope production, neutron irradiation of prospective fuel elements and reactor core components, and for testing various materials under pressures and temperatures occurring in an atomic reactor. Commission-owned test and research reactors have, in the past, served as industry's major source of these services. These reactors will continue to operate, but work will be limited to AEC projects and other projects specifically approved by AEC.

Mammoth New Synchrotron

The Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory, one of the world's two largest operating particle accelerators, ran for the first time recently, producing a beam of protons at an energy of more than 30 billion electron volts (Bev). This is the highest energy ever attained by a particle accelerator. Before reaching this energy, the AGS had run for about an hour at 24 Bev.

The completion of the AGS represents an important step forward in AEC-sponsored studies of nuclear forces and the properties of subnuclear particles. It will enable scientists in the United States to study nuclear interactions at energies about five times greater than ever before possible.

Construction of the AGS, which includes 240 magnets placed in a ring-shaped 18-foot-square tunnel a half mile in circumference, was started in late 1955, following several years of preliminary design work.

In the AGS, the protons are accelerated in three stages. The first stage utilizes a Cockcroft-Walton generator, where protons, derived from a low-pressure hydrogen gas discharge, are accelerated to 750,000 volts. The second stage of acceleration takes place in the linear accelerator, or linac. In the 110-foot-long vacuum tank of the linac the protons are given an incremental velocity as they pass through each gap between 124 accelerating electrodes activated by a high-frequency electrical source.

The proton beam, having now reached an energy of 50 million electron volts, is guided from the linac into the main synchrotron magnet ring through an elaborate injection system of debunching (smoothing out the pulses as they come from the linac), deflecting, focusing, and monitoring equipment. The third stage of acceleration is performed in a half-mile circular concrete-lined tunnel buried under twelve feet of earth, housing the magnet assembly for the AGS.

It is the function of the main magnet, which is divided into 240 units each weighing some 16 tons, to bend the protons into a circular racecourse and to apply strong focusing forces which always tend to bring the protons back toward their orbit within the vacuum chamber whenever they tend to stray away from it.

The magnet itself does not increase the energy of the beam. This is done by 12 radio-frequency accelerating stations around the ring, each one accelerating the beam by 8,000 volts each time it passes. Thus, for each circuit around the ring, the protons gain some 100,000 electron volts. Consequently, in order to reach the final energy of 30 Bev, approximately 300,000 revolutions must be made.

Toward the end of this acceleration period the protons are traveling at a velocity of approximately 186,000 miles a second. At this velocity, the mass of the protons has been increased more than thirty times, as predicted by Einstein's theory of relativity.

The proton beam is then directed at appropriate target substances, thus producing reactions which can be studied by means of the emitted radiations.

Gas-Cooled Reactor

The Atomic Energy Commission has signed an agreement with the Tennessee Valley Authority under which TVA will operate the Commission's flexible, experimental, prototype gas-cooled reactor at Oak Ridge, Tenn.

The agreement provides for financial contributions by TVA toward the re-

(*Continued on p. 179*)

VERSATILE SD-2
SURVEILLANCE
DRONE SYSTEM
BY AEROJET

Designed for night and day battlefield surveillance, the Army's improved SD-2 Surveillance Drone System is an all-weather eye in the sky. In situations of general or limited warfare, the SD-2 provides the field commander with up-to-the-minute information on enemy activities. A product of Aerojet's Aeronautical Division at Downey, California, this versatile drone system features greatly improved performance and mission capability. Advanced flight testing is taking place at the Army's test station near Yuma, Arizona.

The current model carries the Army's latest sensory devices, including radar, infrared, photo transmission equipment, and high speed cameras. Stability in flight is excellent, making camera stabilization unnecessary and reducing system complexity and cost. Flight of the vehicle and subsequent recovery by parachute are remotely controlled, or supplemented by an on-board programer.

Aeronautical Division
Aerojet-General
CORPORATION
Downey, California

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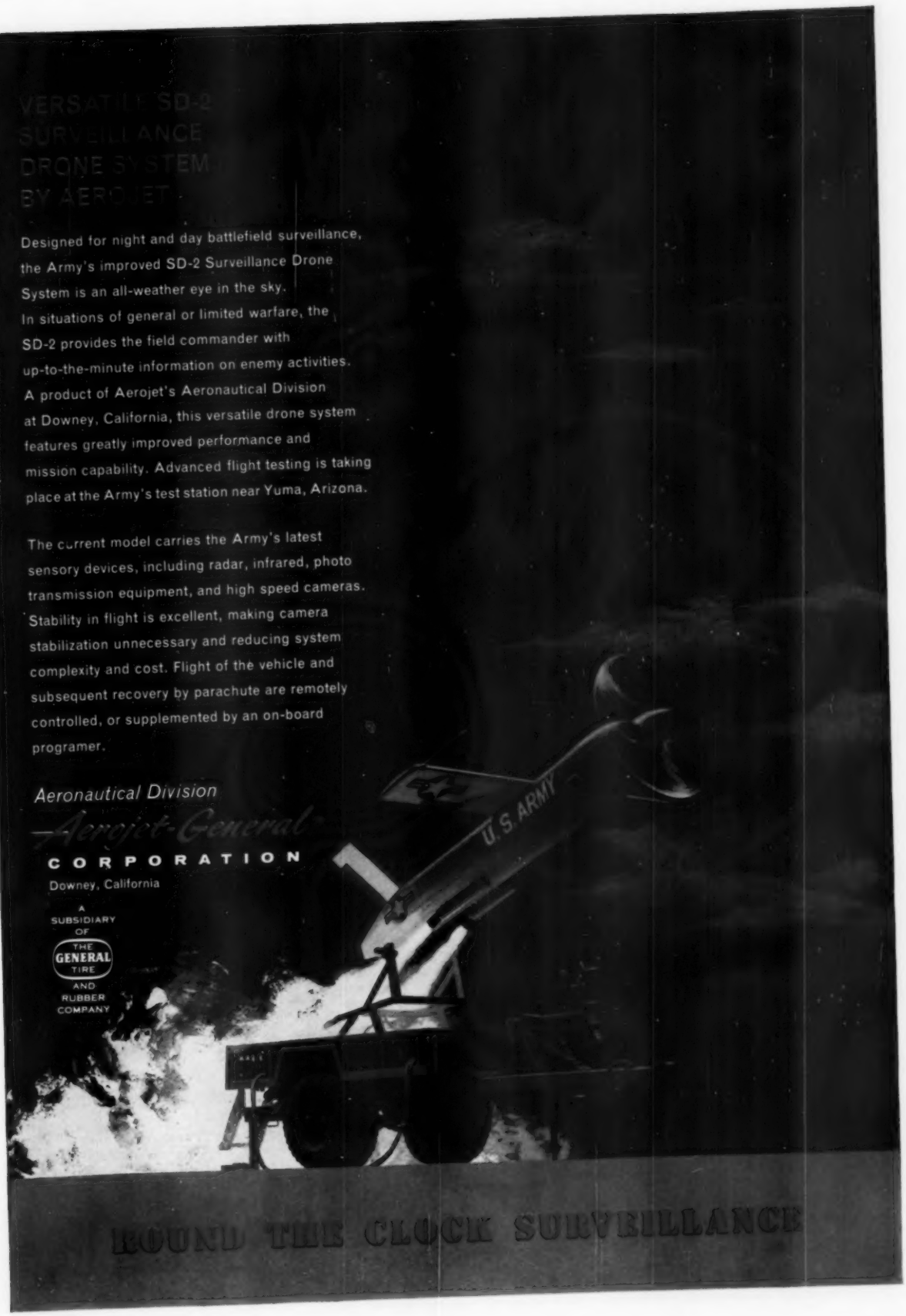


ROUND THE CLOCK SURVEILLANCE

If it moves in 3 dimensions...

Manned or unmanned, guided or ballistic... the Columbus Division of North American Aviation can build it. The Columbus Division has complete weapons systems management capability. It has the R.&D. facilities side by side with the engineering resources. It has systems management experience along with theoretical knowledge. That is why so many of the significant advances in electro-mechanics, electronics systems, propulsion and environment systems, and other areas, are familiar domain at the Columbus Division—one of the most complete centers of advanced systems technology in the world.

NEW TARGET MISSILE—Two missiles in one, this high or low level supersonic target missile for U.S. Army is now in development at Columbus Division. Launched by solid booster, ramjet-powered, it performs from subsonic up through Mach 2, and from ground level to 60,000 feet. NAA Columbus also produces Navy's A3J Vigilante, world's most versatile Mach 2 manned weapon system, and the T2J Buckeye multipurpose jet trainer.

THE COLUMBUS DIVISION OF NORTH AMERICAN AVIATION, INC.

Columbus, Ohio

actor project, both during the current design and construction phase and the later operational phase. Estimated cost of the plant is $30,000,000.

The reactor will provide important experimental facilities for testing fuel elements, gas coolants, and reactor materials in connection with the Commission's gas-cooled reactor development program and also will produce about 25,000 electrical kilowatts, using a turbogenerator to be relocated from the steam plant at the Oak Ridge Gaseous Diffusion Plant. The power will be used at the Commission's installations in Oak Ridge.

The agreement, which extends through June 30, 1968, calls for TVA to provide some design and construction assistance, train operating personnel, assist in preoperational inspection and testing, and operate the reactor. The agreement also provides for purchase of stand-by power by the Commission from TVA for use when the reactor is not producing power.

"Atoms at Work" Exhibit

The AEC's atomic-energy exhibit, "Atoms at Work," will be presented in Lahore, Pakistan, on November 6-26, 1960. Leading scientists from both East and West Pakistan are expected to visit the U. S. pavilion as observers or take an active part in the exhibit.

The 3-week presentation, a part of a Commission's program designed to acquaint people of the free world with the increasingly important role that nuclear energy is playing in their everyday lives, will feature more than thirty displays, including an operating research and training reactor, models of power reactors, demonstrations of the uses of radioisotopes in medicine, agriculture, and industry, and a technical information center.

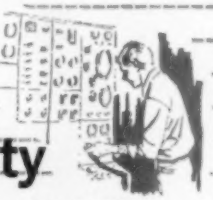
The exhibit, which will cover an area of more than 12,000 square feet, was shown in Cairo, Egypt, last May and then was shipped to Pakistan. The exhibit will be staffed by fourteen guides and demonstrators from universities and atomic-energy laboratories in Pakistan. Ushers and other employees will be recruited from the Lahore area.

Actually, "Atoms at Work," is two scientific exhibits in one. The main section, open to the general public, will be a demonstration of the many ways in which atomic energy is being used for the betterment of mankind.

The second portion of the exhibit will be available to scientists and Pakistan Government officials. The area will include the operating reactor and the reactor-simulator section.

In this portion of the exhibit a number of cooperative research programs will be carried out by Pakistani and American scientists.

*tests prove . . unequaled reliability



*Recent tests were authorized by the Ballistics Missile Division of the Air Force, to evaluate the suitability of valves for use in propellant loading systems for Atlas Launch Sites.

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Vacco, manually operated, 1½ in. Valves were tested at 6000 PSI He. for 500 cycles and performed in the following manner.

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SEATING TORQUE	8.7 to 16.6 ft. lbs.
UNSEATING TORQUE	5.8 to 11 ft. lbs.
RUNNING TORQUE	15 in. lbs. max.
MIGRATION	none

Vacco Valves are best known in the industry as consistant, reliable performers. Be sure to check Vacco design, workmanship and service before specifying hi-performance valves.

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Small: ARMA's operational computer, now in use in inertial guidance systems, employing all semi-conductor circuitry, printed wiring techniques and conventional logical design organization.

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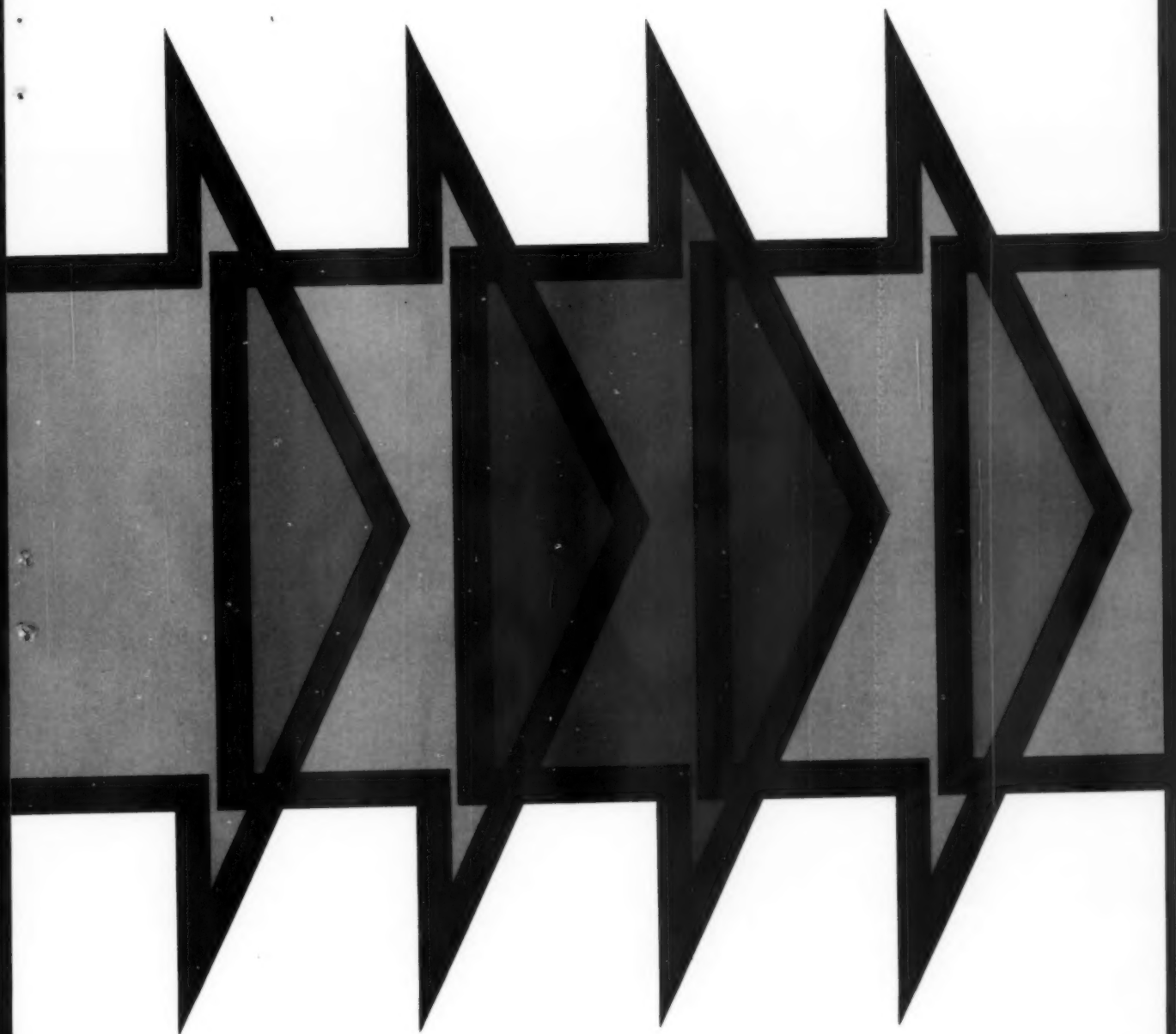

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15 X-A-R 30

ABRASION RESISTANT STEELS

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X-A-R

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Great Lakes Steel is a division of

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X-A-R abrasion resistant steels are immediately available in ⅛″ to 1″ thicknesses, widths up to 72″ and lengths up to 35′. For technical information and supply sources, see next page.

X-A-R

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GREAT LAKES STEEL

Detroit 29, Michigan

NATIONAL STEEL CORPORATION

15 X-A-R 30

TECHNICAL INFORMATION

CHEMICAL COMPOSITION

X-A-R steels are furnished at two specified carbon ranges. These are 14 to 20 carbon for X-A-R 15 and 25 to 30 carbon for X-A-R 30. The balance of the typical composition is:

Manganese	.80%	Chromium	.65
Phosphorous	.020	Molybdenum	.20
Sulphur	.028	Zirconium	.06
Silicon	.60		

TYPICAL MECHANICAL PROPERTIES

	At Brinell Hardnesses of: 363	400
Tensile Strength, psi	180,000	200,000
Yield Strength, psi	165,000	180,000
% Elongation in 2"*	17	16
% Reduction in Area*	56	55
Charpy V Impact at —75°F.	12 (Ft. Lbs.)	7

*Based on standard .505" specimen

ENGINEERING DATA

Resistance to Atmospheric Corrosion (Rural, Marine, and Industrial Environments)	3-5 times copper-bearing or carbon constructional steel
Compressive Yield Strength, psi	Approx. equal to Tensile Yield Strength
Ultimate Shearing Strength, psi	Approx. equal to Tensile Yield Strength
Modulus of Elasticity, psi	29/30,000,000
Endurance Limit (rotating beam)	60% of Tensile Strength
Coefficient of Expansion per °F.	70°F. to 200°F.—.0000062

FABRICATION

Cold Bend Test: Moderate bending can be performed within the usual range of hardnesses. For free bending, it is recommended that a mandrel be used not less than ten times the thickness of the metal through an angle of 90°.

Welding: Low hydrogen electrodes are recommended for welding X-A-R steels. The grade of electrode used is dependent on the strength requirement of the weldment.

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15 X-A-R 30
ABRASION RESISTANT STEELS

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VICE ADM. JOHN T. HAYWARD

Deputy Chief of Naval Operations (Development)

Developing Naval Weapons

Admiral Hayward coordinates Navy's requirements for new armament

OUR fighting forces would be plodding along with antiquated weapons were it not for the dramatic advances made possible by research—a field that was given great impetus in World War II.

The enormity of the research and development program in the Navy alone is indicated by its fiscal 1961 appropriation of almost $1.2 billion. This sum now includes money for testing and evaluation that has been thrown into the research and development budget of all services to indicate the complete cost of bringing new weapons to operational status.

For many years the Navy struggled along without a single coordinating head for its over-all research and development effort. At last, just about a year ago, the necessary coordination was made possible by the establishment of the Office of Assistant Secretary of the Navy for Research and Development and the appointment of a Deputy Chief of Naval Operations in charge of development.

The latter's primary task is to coordinate and issue the Navy's operational requirements for new weapons and equipments; he also integrates the over-all research, development, test, and evaluation programs "in order to ensure that the effort is continuously responsive to long-range objectives, operational requirements, fiscal limitations, and advancing technology."

This large order demands that the Deputy CNO, Development, be aware of all work in this field conducted by the Office of Naval Research, the six technical bureaus of the Navy, and Marine Corps headquarters.

Vice Adm. John T. Hayward, a native of New York City, was commissioned ensign upon graduation from the United States Naval Academy in 1930. He completed flight training in 1932 and served as a naval aviator in patrol and cruiser scouting squadrons and in the engineering division of the Naval Aircraft Factory before World War II.

During the war he commanded Bombing Squadron 106 through many actions in the Pacific. In 1944 he became experimental officer at the Naval Ordnance Test Station, China Lake, Calif., where he was commended for his work on rockets and atomic-bomb destruction patterns.

After a year at Sandia Base, Albuquerque, N. Mex., as Director of Plans and Operations for the Armed Forces, he assumed command of Composite Squadron Five that led the way in operating heavy attack planes from carriers.

From June 1951 to May 1953, he served in the Military Application Division, Atomic Energy Commission, and the following year commanded the escort carrier POINT CRUZ. His next technical duty was in command of the Naval Ordnance Laboratory followed by a year in command of the attack carrier FRANKLIN D. ROOSEVELT.

In January 1957, he was assigned as Special Assistant to the Director of Strategic Plans, Office, Chief of Naval Operations, and in October 1957 moved up to Assistant Chief of Naval Operations (Research and Development) having been promoted to rear admiral. In April 1959, Admiral Hayward became Deputy Chief of Naval Operations (Development) with the rank of vice admiral.

The matching of requirements with research and development does not mean that every endeavor must have a specific feature of warfare in view. Everyone by now is aware of the fact that many of the major technological break-throughs that have enabled us to make 7-league strides in our weaponry occurred in the course of seemingly unrelated experiments. For this reason the Office of Naval Research, within its own Naval Research Laboratory and through many college and industrial laboratories, encourages and finances a large number of scientific explorations.

THE most heavily funded development effort of the Navy is directed by the Bureau of Naval Weapons, recently compounded from the Bureaus of Aeronautics and Ordnance. It is responsible for about two-thirds of all research, development, testing, and evaluation appropriations in the Navy.

The officer who guides this complex organization must have sweeping knowledge of the Navy and a sensible appreciation of scientific possibilities. He must be able to decide whether a promising technological advance should be forced rapidly into a weapons system, returned for further study, or discarded completely.

Vice Adm. John T. Hayward, the first appointee as Deputy CNO, Development, is an unusually happy choice for this monumental task. As a pilot and a carrier commander, he knows his Navy; through his experience in research centers, he understands the scientific field.

Admiral Hayward, as a welcome guest at numerous Ordnance Association affairs, has made a lasting impression on A.O.A. members by his sincerity and vision in discussing defense needs. The admiral can be assured that all members of the Association stand ready to assist in the development of superior naval armament.

To Defeat the Submarine

A quick break-through in underwater detection is urgently needed

Rear Adm. P. D. Gallery

THE overriding priority problem of the United States Navy today is the defeat of the submarine. In our concern about satellites and sputniks in the sky, the public apparently is forgetting that we must "look down" to see a deadly enemy that is getting more dangerous every day—the submarine.

Before discussing our present status in antisubmarine warfare, and possible future steps in combating the sub, let us look at the history of the development of this threat to its present serious proportions.

At the opening of World War I the submarine was not considered a serious threat for several reasons: (1) the submarine had not been effectively used in warfare, had not proved itself, and was treated as a sort of Jules Verne fantasy; (2) even if it had been thought a threat, the Allies considered that the old-fashioned rules of international law protected shipping from attack without warning.

These laws demanded that a man-of-war (submarines included) must warn a ship that was not a man-of-war and allow all hands to disembark before attacking the ship. Ships that were armed or carrying contraband of war, however, were not to be given this privilege. The Germans claimed as the war went on that the Allies were violating the rules governing attack without warning and resorted to unrestricted submarine warfare. The antisubmarine problem was then with us in earnest.

Many students of naval warfare are of the opinion that the Germans "missed the boat" in their submarine effort in World War I because they overestimated the ASW capability of the Allies and did not realize how ineffective they were in antisubmarine warfare.

Our gallant "four pipers" actually had almost no capability in detecting, tracking, and destroying submarines. We boasted after the war that "not one Allied transport under convoy was sunk by submarines." This, the writer submits, was not due to any impregnable defense on our part but to the Germans fear of an antisubmarine threat that did not exist.

The records show that United States destroyers sank *only one* submarine in the entire war (credited to U.S.S. FANNING and U.S.S. NICHOLSON). Conversely, this fear of the actually impotent destroyer resulted in the Germans torpedoing only one United States destroyer, the U.S.S. JACOB JONES.

We realized after World War I how close we came to defeat by an enemy that did not come anywhere near using the full capability of the submarine. One would think that as a result the United States would have made a strong effort to remedy its shortcomings with a view toward being prepared for such a formidable possible opponent in the future. We did not.

Our equipment in World War I consisted of a very primitive hydrophone for passive listening and depth charges to attack a submarine if detected. Nevertheless, practically no progress was made from 1919 to 1930. Not a single new destroyer was built. "Echo ranging" (actually our present-day sonar) was being investigated, but not with any sense of urgency.

As late as 1934 we were still dabbling in sets of six passive hydrophones on each side of a destroyer. Echo ranging was still in the experimental stage.

Between 1934 and 1940 we came into the "echo-ranging era," and twenty-four new destroyers incorporated this sonar in their design. Methods of use were still very elementary: the chemical recorder, the interpretation of doppler by ear, laborious hand plotting, and the need to run in straight and *directly over* a submarine to drop depth charges. Detection ranges were pitifully small and unreliable. False contacts far outnumbered true ones.

WE were learning—but so were the submariners. The boys down below quickly learned the lesson of the "negative gradient," and the use of the bathythermograph for determining "the layer" came into use both by subs and destroyers. This "layer" today continues to complicate the underwater detection problem.

The outbreak of World War II found the Germans slaughtering our ships within sight of Atlantic City, Virginia Beach, and the Florida and Gulf

At the time of his retirement, Admiral Gallery was on the staff of the Commander, Operational Development Forces, Department of the Navy, Washington, D. C. Admiral Gallery now lives in Alexandria, Va.

ports. Only the superhuman efforts of United States industry in pouring antisubmarine ships into the fleet and the development of the airplane for employment against surfaced subs slowed and eventually stopped the onslaught.

We did it by weight of numbers, however, not by any radical new breakthrough in detection. Again, the author feels that the Germans could well have taken greater losses to gain incomparably greater destruction of our shipping if they had not too early credited us with a great ASW ability. We were still weak in detection.

The advent of the destroyer escort, a ship designed solely for antisubmarine work, was the most important step in

Teamwork among various types of craft is vital to any successful antisubmarine warfare operation.

combating the submarine in years. These vessels, produced in large numbers, equipped with the latest detection equipment, and fitted with the new "hedgehogs" (contact explosives), were a source of great worry to the Germans.

The marriage of the airplane to the surface ship in the formation of the hunter-killer groups was even more effective. Such groups as the Block Island, the Guadalcanal, the Bogue groups, and many others, made history in detecting, tracking, and destroying enemy subs. The plane with its radar was particularly important, because the Germans were late in adopting the "snorkel"—a device that could have completely destroyed us had it been in use at the beginning of the war.

THE tide turned decisively in our favor, but again it must be pointed out that we had nothing really new in detection equipment. We had weight of numbers on our side, plus the teamwork developed in the hunter-killer concept, and we were fighting the World War II submarine—not today's true submersible that does not have to surface.

Although the Germans sank millions of tons of our shipping, we now feel that if our own submarines had had the same opportunity they would have done a vastly more damaging job on the opposition. Our submariners learned quickly and did a massive destruction job on the Japanese in the Pacific, where targets were much farther away and less numerous. From our submarine people we learned many tricks that we will have to face in any future war involving submarines.

The end of World War II found us very antisubmarine-conscious, although some of the lively interest had subsided because it was two years since our ships had been seriously imperiled by the submarine. Work on developing greater detection ranges progressed at a slow pace after 1945, principally because the country was tired of war and preferred to forget the possibility of any future war.

"The Russians now have over 450 oceangoing submarines." This headline of a year or two ago was a starter toward awakening the U. S. to its vul-

nerability to submarines. The announcement of the nuclear sub and its accomplishments caused greater apprehension. The birth of the Polaris missile, capable of being launched by a submarine from beneath the surface, really brought the problem to the fore. When people in Kansas City were told they could be hit by a missile launched off our coast, isolationism received its final blow.

THIS brings us up to the present and raises the question, "What kind of shape are we in today to handle the submarine problem?"

A full discussion of this question involves comments on equipment and procedures that are classified—some very highly. However, within the bounds of security, it is possible to present a number of observations on our present ASW capability.

Today the Number One overriding problem in antisubmarine warfare is the same as it was forty years ago—*detection*. Although our detection ranges have tripled over those attainable years ago, the lethal range of the submarine has extended even more.

Sonar is still the primary means of detection. Perhaps it will always be. But there is a pressing need for ranges far in excess of the present and foreseeable sonar ranges for surface ships and submarines. Our scientists are urgently seeking new devices and techniques. The "negative gradient" forming a thermal layer still presents a formidable problem. One possibility—and many scientists scoff at it—is the use of radar. This subject, however, is receiving close study for a possible breakthrough.

Another avenue being explored is the use of magnetic anomaly detection equipment in aircraft. This involves detection of a sub by devices indicating distortion of the earth's magnetic field due to the presence of the submerged vessel. "MAD," as it is commonly called, is extremely limited in range and, we are told, will never be of great enough range because sensitivity varies inversely as the cube of the range.

"Sniffer gear"—detection by a plane of the exhaust fumes of a snorkeling submarine—may hold promise.

Infrared detection is under investigation—sensitive devices can detect very small water temperature differences in wakes caused by the passage of submerged submarines.

Sonobuoys are receiving more attention than heretofore and may increase the value and role of the airplane in antisubmarine warfare. Explosive echo ranging is being investigated and developed for use in connection with sonobuoys.

Shore-based systems of detection using new methods also are under study and development and have received some publicity in Project Artemis.

"Bottom-bounce" methods of detection by bouncing echoes off the ocean floor and layers are being hopefully developed at several laboratories.

"Convergence-zone" phenomena are the subject of research and development. By this active method submarines passing through 35- 70- and 105-mile bands from a sound source may be detected.

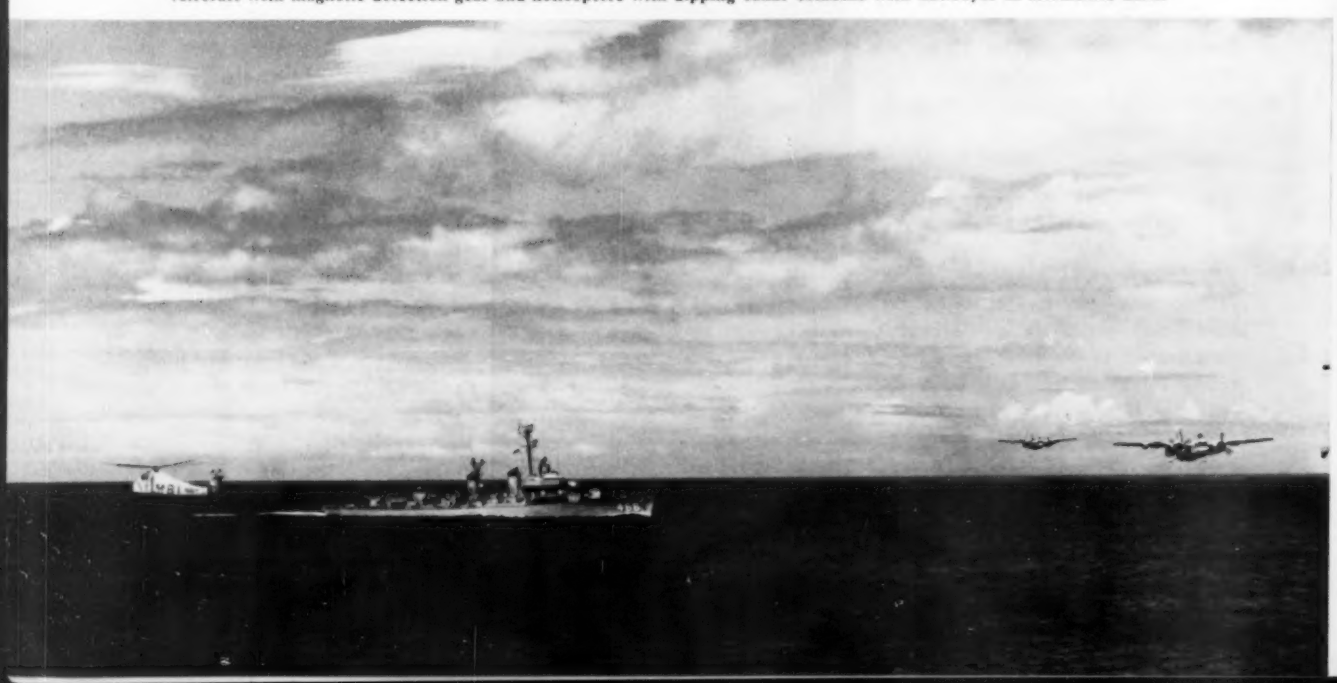
Investigation of the properties and uses of the deep sound channel is a matter being pursued by both the United States and Great Britain.

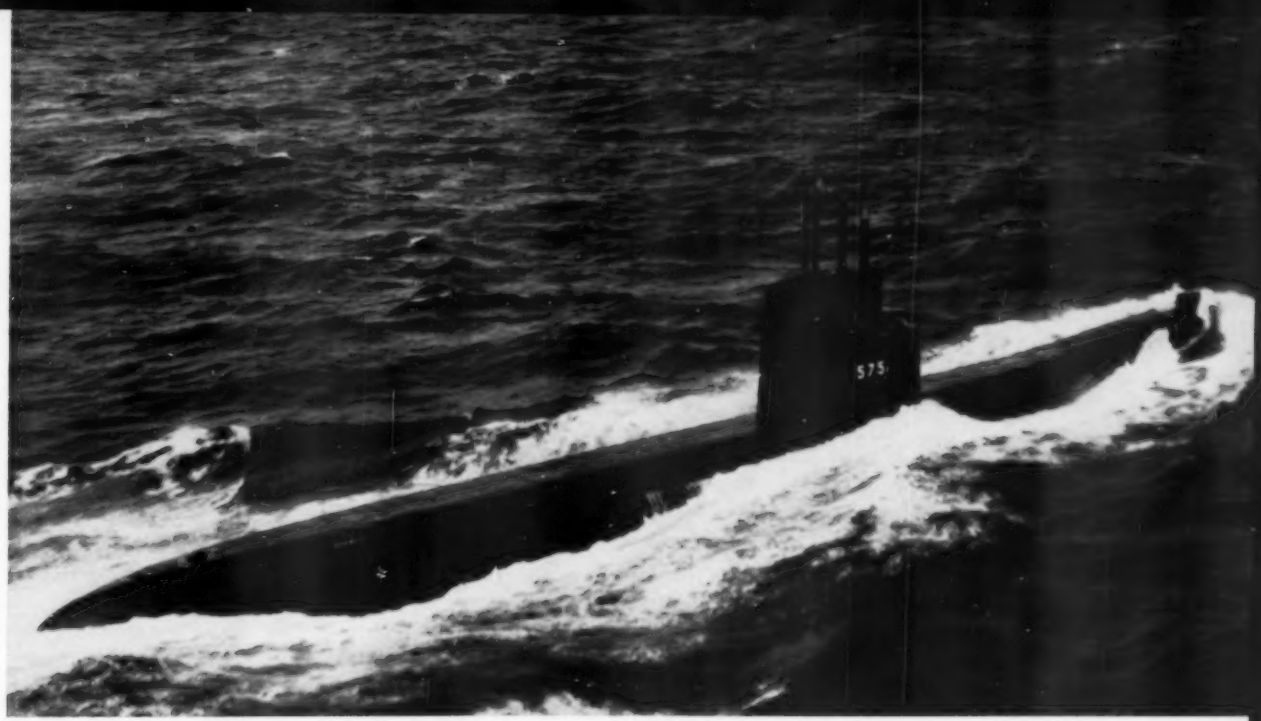
USE of moored sonar buoys, bottom-located buoys, underwater sound sources, and receivers are all under study. The NOBSKA committee, a group of scientists who spent a summer at Woods Hole Oceanographic Institute in Massachusetts in 1955, studied many possible methods of combating the submarine.

Any idea that is brought forward in this difficult detection field is given consideration by the Navy Department—no matter how exotic it may appear. The solution is so vital to our country's defense that no possibility can be overlooked.

The foregoing gives some idea of the many avenues of approach to the detection problem that are being explored. The main point is that the detection of submerged submarines is definitely not solved—and detection is the key to the

Aircraft with magnetic detection gear and helicopters with dipping sonar combine with destroyer in submarine hunt.





Atomic submarine SEAWOLF joins recent antisubmarine exercises off Florida coast (all photos courtesy U. S. Navy).

whole problem. "After all, the only difference between a surface ship and a submarine is that the submarine can hide." Take that advantage away and the reason for the existence of the submarine vanishes. This is easier said than done, and may be an oversimplification.

Such an observation reminds the author of the old story about a football expert who was talking to Knute Rockne regarding the great Illinois halfback, Red Grange. "He's not so great—all he can do is *run!*" said the expert. Rockne witheringly replied, "Yeah, and all John McCormack can do is *sing!*"

It appears that a Manhattan Project approach to the antisubmarine problem is called for. If we put the top scientific brains to work on beating the sub, and allow adequate funds for research and development, we will somehow reach a solution. Our complete dependence on sonar with its marginal improvements as the years roll by is evidently not good enough. We must pierce the protective covering of the oceans that makes the submarine almost invulnerable to detection.

We are told that radar and radio will not pierce water—attenuation is enormous. However, there is a suspicion that extremely low frequencies may hold some promise. We still do not know enough about deep sound channels. Magnetic anomaly detection does work for small distances—perhaps this field can be expanded to useful search and detection ranges.

Escort destroyer WALLER launches long-range antisubmarine rocket "Alfa" during recent ASW exercises in Atlantic.

There may be detection means that have not even been discovered yet. The only way to find them is by an all-out effort, using the top scientific minds in the country.

We have not discussed the three steps that follow detection—classification, localization, and destruction. Many feel that they can be handled satisfactorily once the first step is accomplished. Undoubtedly classification (determining whether the target is a submarine) will take great effort, but in time of war, with controlled shipping and knowledge of the whereabouts of our own subs, this problem is easier, and classification comes *after* detection in time and in importance.

The question of whether the destroyer, submarine, airplane, or shore-based installation should have primary emphasis in ASW is another problem. Many feel that *all* are necessary.

A GREAT number of authorities do not agree with those proponents of the plan of relying entirely on using submarines to fight submarines. "But the submarine is in its own environment!" However, the number of killer subs required to cover millions of square miles of ocean is fantastic, and at present we are building only extremely expensive atomic subs in small numbers.

The claims of some proponents for the ability of the airplane to combat a completely submerged submarine are just not true. Their simple and graphic illustrations in current magazines of planes finding and killing subs are misleading. First of all the plane has very little capability of finding a completely submerged submarine.

As of today, magnetic anomaly detection, the airplane's primary means for detecting a submerged sub, is at its best after the sub has been initially detected—then MAD can localize it. And the problem today is finding the submerged submarine, "keeping them down"—as aircraft did in World War II—is no longer the complete answer.

The destroyer is falling behind in the ASW picture, because its ability to detect at long enough ranges is very low. Our "tin-can" sailors have more "know-how" in this sub-hunting game than anyone, but the advances in the submarine's capability have been much greater than the progress of destroyer detection equipment. Improvements in detection are always gradual—we need tremendous improvements to reach satisfactory ranges. By "satisfactory" we mean ranges beyond those at which the enemy sub can fire at and hit the surface ship. This means over 20,000 yards today, and it will become greater.

THE helicopter is being pushed as an antisubmarine vehicle for search and attack. Several obstacles present themselves: (1) a long-range detection sonar is still needed; (2) the noise and vibration problem must be solved; (3) a true all-weather capability must be obtained, including ability to hover safely at very low altitudes.

Use of the helicopter as a drone is being investigated. Drone helicopters have already been flown and proved reliable on land. Sea and wind conditions make their use difficult, but the problems are not insurmountable if the prospective gains are worth the investment.

Blimps are claimed by some to have the advantage of comparatively long endurance, a quiet stable platform, and ability to hover. They are still not out of the antisubmarine picture but are not getting the emphasis the blimp enthusiasts would like.

The advent of the Polaris submarine concept gladdened the hearts of the submariners because it suddenly brought them into the front ranks of our national offensive team. It had another important and predictable effect: it woke up many inland people to the fact that their homes in our Midwestern States were suddenly vulnerable to attack by Polaris-type enemy submarines. This should arouse a massive interest in solving the submarine-detection problem in order to prevent attack from the sea on these heretofore safe areas.

The increase of $320 million in ASW funds voted by the House in the 1961 budget is a heartening sign. The amazing submerged voyage of the TRITON around the world emphasized again not simply the potential of our own submarines but the threat posed by enemy submarines which eventually will be able to duplicate this feat. Consequently the demand for action to defeat this menace is more urgent—greater ASW effort is necessary.

The following quote from *Time* magazine points out an example of the avenues of approach that must be explored to solve the ASW problem:

". . . . this $68,000,000 radio transmitter complex, planned on the Maine coast, should be capable of sending orders to subs operating *under the surface* (italics supplied by the author in this entire quotation) of the North Atlantic and Arctic Oceans. The Navy says the signals, of very low frequency, will reach 'deep down.' Best estimate is that they will *penetrate more than 100 feet* of water. Cloud on the horizon, no bigger than a boatswain's hand, as the sun rises on a new era in underwater communications: if radio waves can penetrate water to communicate with submarines, they may eventually be usable with instrumentation for *detection of submarines* which are now immune from anything but surface sighting and chance encounters with short-range sound devices."

THIS startling and revolutionary development could well be the step needed in starting toward the long-sought "break-through." At present it is not at all confirmed, but such ideas as this are typical of the approaches that should be followed in an all-out research and development effort.

In the opinion of the writer, we are not fully applying our scientific knowledge to this problem, nor are we putting the financial backing behind it that antisubmarine warfare must have. ASW lacks the glamour of guided missiles and satellites, but the peril is almost as immediate. Our Polaris missile will be operational this year—the Reds cannot be far behind.

This demands a coordinated and concerted effort. Again we say that this problem could be solved if we made an all-out effort similar in concept and resources to that applied in the Manhattan Project or in the Polaris program. It may well prove to be just as vital to our country.

The New M60 Tank

Mark S. Watson

THE U. S. Army Armor School at Fort Knox last June began its series of transitional courses in maintenance work on the M60 tank and the closely related M113 armored personnel carrier. A few weeks earlier the first production model of the M60 had come from the assembly line of the Chrysler Delaware Defense Plant at Newark, Del., with 359 to follow. Shortly thereafter the Army announced a contract for 720 more from the Detroit plant.

Meantime the Congress was pressing for a considerable increase in 1961 authorizations for Army modernization, emphasizing the M60 tank. The final defense appropriations measure makes possible in the visible future the acquisition of more tanks, plus a considerable addition to the 2,280 M113 carriers already on order.

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These events in combination bring a good deal of cheer to an Armored Force which for a long time has been pressing for more firepower and more range than can be squeezed out of the M48 Patton tank and for a much more rapid delivery to the using forces than last year's budgetary economies promised.

Quantitatively, the 1,080 M60's now contracted for make a start, supplying the goodly number required for field tests, for training of the numerous cadres, and quite enough in addition to meet all needs of the first of the Armored divisions scheduled to receive them. Qualitatively, the question of their sufficiency is succinctly answered—they will be able to fight any tank in the world today.

No weapon or instrument of defense is supreme indefinitely, and obviously ordnance research is working toward the possibilities of something better a few years hence—presumably much lighter, more mobile, with yet greater firepower, conceivably with better resistance against radiological menace—but the M60 has been judged a very marked advance over the Patton and the best piece of equipment available today. Nobody has said it better than a veteran tanker with his remark, "It's the first time we have been in the position of outgunning our opponent."

This particular capability, which is undeniably the first need of the Ar-

mored Force, is supplied by the British-designed, American-made 105-mm. gun M68 with a velocity very much greater than that of either the Patton's 90-mm. gun or the 105 of our present heavy. Exact comparison of performance is difficult, because meaningful comparison calls for identical test conditions as to range and angle of impact, and the practical battle range of the one is not that of the other.

In broad terms it may be said that the new 105 with its primary ammunition has a kinetic energy from 20 per cent to nearly 100 per cent better than the Patton's 90. This, plus greater precision ("You can drive nails with it," reports an enthusiastic gunner), provides confidence in an appreciably higher likelihood of that first-round kill which is the great hope of every tanker.

THE British development of this new and impressive gun induced a change in our own ordnance planning, for reasons which should be fully understood. With tanks, as with other weapons, there is a fairly normal cycle of development, based on the time required for effecting an advance sufficient to justify tooling-up and full field replacement. The advance may be in armament, or propulsion unit, or other major component, or, best of all, in all three, accompanied by the latest betterment in electronic gear which never ceases to improve but which is readily fitted into the changing structure.

The tank cycle is roughly 5 to 6 years. Thus the M46 tank came into being shortly after World War II, the M47 in the early 1950's, the M48 in the mid-1950's, and now the M60 in the early 1960's. The proposal for the Patton's successor had been a projected T95. In some respects it would have marked a more radical change—notably in a truly sharp reduction in weight by nearly ten tons—but the T95 design called for fully two more years of development and the Armored Force's need was for a markedly improved gun right away.

The 120-mm. gun in our heavy tank is too big for the M60 and no less bulky piece now in readiness meets the need. The inevitable decision was to proceed with the M60, plus the excellent British 105-mm. gun, inasmuch as the entire system could be ready on schedule. The T95 tank project accordingly has been shelved, but the extensive development work done upon it will bear fruit later on.

The first merit of the new tank's new 105-mm. gun M68 is its very high muzzle velocity, greatly exceeding that of anything else of that caliber, thanks to the discarding-sabot pattern of its armor-piercing ammunition. The "sabot," up to the time the shell leaves the muzzle, confines the gas from the exploded charge and thus drives the slightly smaller shell itself forward at hypervelocity.

The surprising ruggedness of the gun is a welcome quality. The tube itself is removable, permitting field replacement and averting the need for prolonged absence of the tank from combat. The principal American improvement is the redesigned breech mechanism, reducing weight from 1,200 to 800 pounds. Other ammunition for the main gun will include an antipersonnel round and a chemical round. Planned stowage is of 57 rounds for the 105, plus 5,950 rounds for the coaxial 7.62-mm. machine gun and 1,040 rounds for the caliber .50 machine gun mounted in the cupola.

In this new cupola the tank provides its commander with much-needed additional space and also with all-around vision. The crew space in the turret is slightly enlarged, and some measure of comfort is added by the wire-mesh seats, similarly supplied in the driver's compartment.

For the gunner there is the new and greatly improved M17C monocular range finder, which provides distance measurement of very great accuracy through a wide reach of medium-to-long distances, and does so quickly. Supplemental sights for the secondary weapons are placed with greater attention to ease of use. Again, the emphasis is on quick firing and expectation of the all-important first-round kill.

The power plant is an air-cooled, 12-cylinder diesel, 1,200 pounds heavier than the Patton's engine, but quite clearly very much more efficient. The prime measure of its efficiency, in the tanker's mind, is its much greater range, with 250 to 300 miles spoken of as a possible distance to be covered in a theoretical combination of cross-country and road travel, representing a 40 per cent stretch of the Patton's reach.

Nothing is more important logistically than this long reach upon which an armored task force commander (and the planning direction at headquarters) now can begin calculating. It applies to the possibility of needed wide dispersion and quick rallying which atomic-age battle requires. It applies to the planning of a multifingered deep reconnaissance and a quick reconcentration at the chosen point. It applies to the ability to make a very long penetration deep in enemy territory without agonizing worry over early fuel exhaustion.

There is great promise in the almost simultaneous development of this powerful, long-range tank and the new M113 armored personnel carrier which by reason of its remarkably light weight (nine tons, compared with its predecessor's twenty tons) has the ability to keep pace with its natural companion in rapid deployment.

The M60 acquires its long legs by reason of the new diesel plus the new transmission which is an integral part of the power plant. The entire tank, combat-loaded, weighs 51 tons, which is only a modest reduction from the Patton's 52½-ton total. Even so, the employment of light metals in many possible places (aluminum turret-platform, stowage boxes and racks, road wheels, support rollers, etc.) has helped so much as to permit heavier armor where it is particularly needed.

THE 3,000-pound reduction also is of help in operating over very rough ground and in conquering a 60 per cent grade and a 3-foot wall. The tank fords 4-foot streams.

Of the accompanying betterments a great deal can be said, but some of the heartiest approval is over the lessened complexity of the new system. This applies not only to the diesel engine, whose large virtues are headed by its simplicity and resultant ruggedness and

reliability, but also to the improved transmission system, the new gun, and the range-finding and sighting mechanisms referred to.

Simpler in operation than its predecessors, the M60 is easier to handle and hence easier to learn. As it is simpler in maintenance as well, the maintenance-and-repair echelons will need less time to learn their jobs. In both these areas, therefore, the training time for new men is reduced, and in a service where rapid turnover is still a burden, shorter training time is a boon.

Battle experience has had harrowing examples of losses due to the blaze-up of the tank's own gasoline, ignited by enemy fire. Here the diesel fuel, much less inflammable, marks a very real safety betterment. The supply problem is somewhat reduced also, thanks to the lower volatility of the diesel fuel which assures less waste from evaporation.

BECAUSE the Army has had long experience with budgets and with national purse-guardians' reluctance to let go of old models until the equipment is not only obsolescent in design but also exhausted from plain age and hard work, many of the M60's elements have been so designed as to permit transplanting to the late-model Pattons.

This does not mean necessarily that either swift or complete retrofitting of the Pattons is contemplated. It means, rather, that as the power plant, for example, of an otherwise useful Patton reaches a point where its own repair or actual reconstruction is no longer warranted by reason of comparative cost, it may very well be replaced bodily by the new diesel package.

This could well be possible, too, with the new gun, thanks to the alteration in the British breech mechanism which has been mentioned, and possibly with the fire-control system and even the more comfortable and less vulnerable turret. The Patton is basically a good tank. Retrofitting it in these respects has much to commend it. Notably such a plan would avoid creating an overlarge inventory.

"Nobody can ever look admiringly at the latest improvement, sigh happily, and say 'This is it' " remarked an old tanker the other day. "The M60 is a mighty jump forward, but it still is an interim weapons system, just as were its predecessors in each of those cycles. It manifestly is the best thing our industry can put out this year or next or for a few years more. I am convinced that our T95 would have represented an advance in one important respect, but it would have needed a couple more years and it would have cost a good deal of money to develop and it was just too much money for another short interim gain.

"THE M60 will do us until we can prove that another cycle is near its end and that there already is assurance of major betterment in some very important respect or, better, in several important respects.

"What and when will that be? I doubt that we will soon get much better range or better accuracy than this gun promises, and I have no hope for a true 'revolutionary break-through' here. But we always can bring about a gain in durability or reliability or both, and we have just shown that we can gain these while actually reducing weight, with all the satisfaction which weight reduction affords to an Army seeking more and more mobility. We strive always for just as much slimness and low silhouette and speed as we can get without excessive sacrifice of protective armor, particularly protection from that battlefield radioactivity which we must plan

The M60 tank, replacing both the M48 Patton and M103 heavy tanks, mounts a 105-mm. gun (Army photo).

against. In designing to get one advantage there must be some conscious sacrifice of another."

The Ordnance people are properly as proud as industry itself over the extraordinary degree of durability which new metallurgical skills have made possible in one of the most worrying of all tank parts—the track—whose mortality rate in troublesome terrains was terribly discouraging to combat force commanders in World War II. What Ordnance is aiming at, and hopefully too, is ability to get 4,000 miles from one set of tracks, as well as from other equipment.

That sounds like an Armor commander's dream, for it is more than twice what an M48 could extract from its treads, yet today the new tracks are testing as much as 3,000 miles in hard-wear endurance tests which used to bring failures at 1,500 miles. This is one of the most significant advances over World War II equipment, and it would be foolish to think that metallurgy is yet at the end of the road.

Today's material is the better, certainly, because design itself is more knowing and can make better use of the alloys which fifteen years of metallurgical progress have developed. The diesel engine of today is longer-lived than that of other days and able to go very much longer without overhaul than the carburetor type.

IT is not always true that "quality beats quantity." Early in World War II in numerous fire fights we had quantitative superiority over the German guns, which still beat us—we thought by reason of better quality alone. But as the war went on, the German guns became manned by new gunners with less training, and the situation soon changed. Quantity plus quality plus training makes a grand combination.

The quality of the M60 has been pretty well determined, for the initial service tests have revealed such defects as are readily disclosed and these have been corrected by modifications. Now the real trial is on—the field tests by troops themselves.

Ordnance experts, who have devised the most rigorous mechanical tests for the Army's most skilled experts to apply, still state grimly that the best of all testers of any weapon is invariably the unskilled GI, whose indomitable persistence can bring to light defects which qualified experts never dreamed of. When these field tests are passed successfully, the M60 will truly be ready for delivery to the cadres now in training and then to the using forces.

One gathers that the first big distribution will be to Armor (rather than to the armored element of Infantry divisions) and just as surely to Seventh Army Armor, for here is our best instrument of highly mobile warfare and our most conspicuous field need.

Today's doctrine clearly calls for destruction of an enemy's interior resources; indeed it is a long time since the main guiding purpose was to provide massive (and dubious) breakthrough of a strong enemy front line. Looking back to General Marshall's formal biennial report of 1945 one finds the revised high-level concept:

"We designed our armor as a weapon of exploitation. We desired to use our tanks in long-range thrusts deep into the enemy's rear, where they could chew up his supply installations and communications."

Tactical planning to meet all the changes in weaponry is continuous. The pressure now is notoriously for more and more mobility. It may be that necessity is the mother of invention, and that the sinister threats of the atomic age have pushed us toward these new powers of dispersion and long-range electronic communications.

"The Ordnance people are properly as proud as industry itself over the extraordinary degree of durability which new metallurgical skills have made possible in one of the most worrying of all tank parts—the track—whose mortality rate in troublesome terrains was terribly discouraging to combat force commanders in World War II. What Ordnance is aiming at, and hopefully too, is ability to get 4,000 miles from one set of tracks as well as from other equipment.

"This sounds like an Armor commander's dream, for it is more than twice what an M48 could extract from its treads, yet today the new tracks are testing as much as 3,000 miles in hard-wear endurance tests which used to bring failures at 1,500 miles."

It may be, too, that invention is the mother of more invention, for certainly our new electronic ability to see and hear and talk over vastly greater ranges has encouraged us to accompany this ability with the power to move more swiftly to those longer ranges. Helicopters now transport personnel and fairly heavy equipment across ordinary country as efficiently as do vehicles and also over difficult terrain which is impassable by ordinary vehicles—even by a tank which can surmount a 60 per cent grade and traverse a 4-foot stream. Firepower has jumped ahead in range and lethality and rapidity of delivery. Everything presses to greater ability, greater dispersion, greater reliance on small units.

Always, too, there is an accompanying study of new organization, the better to employ the new weapons in the new tactics and to attain that flexibility which is at once the aim and the nightmare of planners.

While it is obvious that planning in armor and elsewhere must be for capability in nuclear and also in nonnuclear war, the awful fact is that the one capability tends to combat the other. The one needs a small squad; the other is best served by a large squad. Nuclear war requires one weapon and one defense; conventional war needs something different.

Much of the organization planning therefore must be a compromise, which inevitably means that, when the test comes, there is peril of being too long here and too short there.

ALL this affects the support of the tank. Fortunately it does not affect the tank itself. It must be seen that the much greater ranges of which the new armor will be capable will force some large changes in logistical support and planning. One would anticipate much larger use of Goer types and of cargo helicopters just around the corner—budgets permitting. The M60 tank and the M113 personnel carrier are just a new beginning.

Rockets for Space Power

Though the Soviets lead us in payload weight, our satellites have gathered much valuable information and we are now planning manned vehicles for exploration of the moon and then the nearer planets

Maj. Gen. Don R. Ostrander, U.S.A.F.

Director, Launch Vehicle Programs, National Aeronautics and Space Administration, Washington, D. C.

THE question has been repeatedly asked, and heatedly argued in recent months, as to whether we are in a space race with Russia. Whether we are or not is a matter of semantics. Strictly speaking, the word "race" normally connotes two or more contestants running on the same track, taking the same hurdles, and trying to reach the same goal. In this case we do not know what the other track is like, we do not know the specific goal of the other fellow, and we do not know how hard he is running.

In addition, it would be a mistake, even if we did know these things, to try to pattern our program on this sort of "me-too," "anything-you-can-do-I-can-do-better" type of approach. We are convinced that we should set our goals, point toward them with a broad, logical, scientifically sound program, and then run just as hard as we can.

In the long run, we will be better off than by simply shooting for spectacular propaganda firsts. If in the process we achieve significant firsts, it should be as an outgrowth of our own sound program, not as our sole and primary goal.

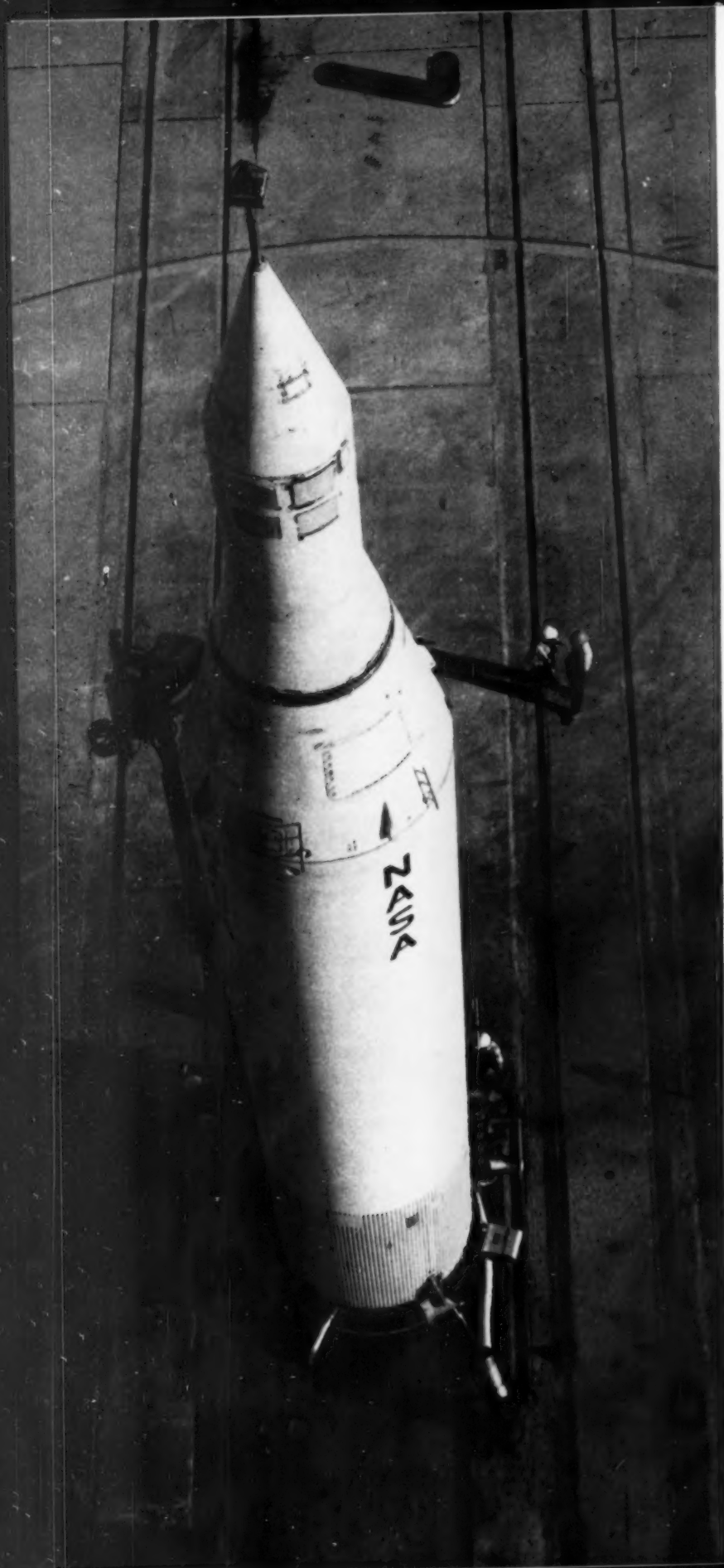
Leaving semantics aside, however, we have to face the fact that we are in a competition—whether or not you want to call it a race—just as we are in financial, economic, psychological, and ideological competition across the board. Certainly there is no question in my mind that, at least in my area of responsibility—the area of greater rocket weight-lifting capability—we are in a race, and I plan to conduct my business accordingly.

A Juno II rocket is readied for NASA-Army launching of Pioneer IV space probe at Cape Canaveral (Army photo).

Since the Soviets placed Sputnik I in orbit in October 1957, the United States has attempted fifty launchings. These efforts have succeeded in injecting twenty-one payloads into earth orbits and two on journeys around the sun. The record shows a box score of 30 per cent successes in 1958 rising to 58 per cent in 1959, then falling slightly to 54 per cent thus far in 1960.

These statistics reveal two significant points. First, 50 major launches in 2½ years represent a sizable start for the United States space program. The second point that these figures emphasize is the importance of repetitious use of a vehicle in increasing its reliability. The marked upswing in reliability in 1959 can be laid primarily to improvements in design and to the correction of component deficiencies after diagnosis of failures.

We have no accurate way to determine the reliability which the Russians have achieved in their space program so far. We know of seven Soviet successes, but we do not know, of course, how many of their attempts resulted in failure.



It is no secret that the Soviets outmatch us in the department of rocket thrust and that as a result they have the capability of placing much heavier payloads in space. The explanation of this situation is traceable primarily to the fact that each nation sized its rocket engines to place a high-yield warhead on an intercontinental target. Our warhead technology permitted a lighter vehicle requiring lower thrust than that of the Soviets.

IRONICALLY, our ascendancy in warhead design limited the weight-carrying capability of our initial generation of space boosters to a level well below that of the Soviets. Furthermore, with the exception of the Vanguard program, our development of specialized launch-vehicle equipment did not really get under way until about a year after Sputnik I.

Because of this late start and the remorseless facts of rocket development lead times, we have yet to put into service the new, more powerful, launch-vehicle equipment which will enable us to match or surpass Soviet payload achievements.

Although we are behind the Soviets in the weight-lifting area, it does not follow that we are far in arrears in over-all rocket technology—in our knowledge of how to design, develop, and use complete and integrated space systems. In fact, I am confident that we are not significantly behind the U.S.S.R. if you consider this field as a whole, and I think that we may well lead them in many specific areas.

However, the yardstick by which our space accomplishments should be measured is not solely payload weight, nor for that matter the total number of successful launchings, but rather the extent and quality of useful scientific information that our payloads have returned to us and the distance that this new knowledge has carried us toward our goals.

Our knowledge as to the scientific value of the data that the Soviet space program has gathered to date is far

A modified Jupiter IRBM, rising 76 feet above its launching pad, was used to send Pioneer III aloft (Army photo).

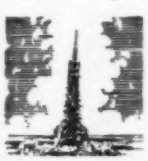
from complete. There is, therefore, no real way for us to compare the two programs on this basis thus far. However, our own effort has contributed very significant information of great value to our over-all program.

Our program on space exploration really has three elements with closely interrelated goals. The first of these is the space sciences program, which seeks to learn new facts about the shape of the earth, its upper atmosphere, the ionosphere, the earth's magnetic field, the radiation belt, solar-terrestrial relationships, etc.

Each of the satellites and space probes in this program is instrumented, and its flight path is planned to add in a specific way to the over-all pattern of knowledge that we are painstakingly building. Many of the experiments undertaken as part of our space-science work are inspired by requirements of other elements of our program.

FOR example, determination of the extent, intensity, and time variations of the radiation within the radiation belts; measurements of temperatures inside and on the outside surfaces of satellites; and measurements of the energy and frequency of micrometeorite impacts—all are of great importance to the Mercury and follow-on man-in-space programs whether civilian or military.

This, of course, is the second of the three elements of our NASA space program. The goal of Project Mercury is not the propaganda value of a spectacular first. Rather, its goal is to determine the functions that a man can usefully perform in space to pay his way in future space exploration. We have made excellent progress with Mercury so far. If all goes well, an astronaut should make his first suborbital flight late this year and orbit the earth in 1961.



The third element of our program relates to the application of the knowledge which we gain to space systems which can be applied to the good of mankind. For example, we plan to place in orbit under our Project Echo large metallic-coated mylar spheres which can be used as passive reflectors to permit microwave communication over vast distances. Also, weather satellites such as Tiros I and its successors, Tiros II and Nimbus, will, we hope, allow major advances in weather forecasting.

THUS we are embarked on a scientifically sound, balanced, and aggressive program of our own design. We are literally building our fund of knowledge of space from the ground up, guided by definite goals—our own goals.

To date, we have been less handicapped by the lack of greater payload capability than is popularly supposed, primarily because much of this early exploratory work can be accomplished with the launch vehicles we have had available to date. I certainly do not mean to imply that we would not like to be able to launch heavier payloads, and in the near future we are going to have to achieve order-of-magnitude increases in our ability to carry heavier weights into space. Furthermore, we are going to have to fly more complex flight paths demanding higher degrees of guidance precision than we have needed so far.

Now let us examine our program to create this new generation of launch vehicles we need for the task ahead.

The philosophy upon which our launch-vehicle program rests is based upon three fundamental principles:

1. We are creating a standardized fleet of trucks, if you want to call them that, with a minimum number of different types in the fleet.

2. Closely linked to the first, we propose to attain reliability through repetitive use of the vehicles in our fleet.

3. To avoid early obsolescence, we want to ensure that each new vehicle we develop incorporates the most advanced technical approaches and maximum growth potential consistent with the reliability we require.

Concerning the first two of these principles—minimum variety and repetitive use of standardized vehicles—our objectives here are, of course, economy and reliability. The costs of developing launch vehicles are already high, and they are going up in a geometrical progression with each new, larger, and more advanced vehicle that we add to our fleet. That is why we are conducting cooperative programs with the Air Force on certain vehicles such as the Scout, the Agena B, and the Centaur.

The Scout and the Centaur are being developed by NASA for use by both agencies. The Agena B is an Air Force upper-stage development from the Agena A which, employed with the Thor as a bottom stage, has earned an impressive record for reliability in the Discoverer series of launchings from Vandenberg Air Force Base.

NASA canceled the development of an upper stage which, when used on top of the Atlas missile, would have possessed practically the same payload capability as the Atlas Agena B. There was nothing inferior about the NASA vehicle, known as Vega. It was simply that the Agena B had drawn ahead timewise and could do the same job, plus the fact that with a cooperative program with the Air Force we would get more total firings and consequently more reliability.

The contribution to reliability of amassing a large number of flights on a given vehicle is obvious. However, we do not subscribe to the "develop in haste and fix at leisure" route to reliability. In our kind of business such an approach is patently unacceptable. These devices have to work the first time they are launched or the entire cost of the flight is wasted.

Consequently, reliability is considered at every step, from conceptual design, through detail design, selection of materials and components, development test, flight test, production quality control, and launch procedures—our entire spectrum of operations.

ON the other hand, we do not propose to allow our desire for reliability to become such an overriding obsession that we timidly decide on the tried and true—and often obsolescent—approach in planning each new vehicle. That is why we have the third principle mentioned above. The tough job is to have both reliability and long, useful, life.

NASA is tackling this job by aggressively probing for real break-throughs which promise significant gains in mis-

sion capability. We bet heavily to win—but only after we have solid evidence that we have a winner.

We are still limited to the launch vehicles with which the United States began its space program, or their direct descendants. A few have been retired—the Jupiter C which served us well back in 1958 when we so greatly needed a United States satellite in orbit to repair, in some measure, our badly mauled prestige; and the Vanguard which more than earned its development cost in the information provided by the three scientific payloads that it orbited. In addition, Vanguard paid dividends by giving us upper stages for the Thor-Able, the Thor-Delta, and the Scout vehicles.

Also due to be retired after this year is the Juno II, based on the Jupiter IRBM, and the Thor-Able. The Thor-Delta, which is a Thor-Able improved through the addition of coasting flight attitude control and the accurate and flexible Titan radio-inertial guidance system, will be used through 1961 in a 12-vehicle program, but we plan no follow-on procurement of this vehicle after that.

All the vehicles we are retiring are destined to be replaced by two new ones—the Scout and the Thor-Agena B—the Scout because of its relatively low cost and its high reliability potential and the Thor-Agena B because of its combination of greater payload, flexibility of operation, and, again, its potential high reliability.

AS far as payload capability is concerned, the Vanguard and Jupiter C could place a 25-pound payload in a 300-mile orbit. The Juno II could perform the same mission with a 100-pound payload, the Thor-Able with 200 pounds, and the Delta configuration will more than double this performance with about a 480-pound capability. Of their successors, Scout can handle a 200-pound payload for a fraction of the cost of its predecessors, and the Thor-Agena B will be able to put 1,250 pounds in a 300-mile orbit.

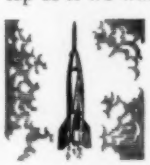
The Agena B stage will also be used by NASA, as well as by the Air Force, on top of the Atlas as a first stage. The Atlas booster will increase the 300-mile-orbit payload capability of the Agena B to about 5,300 pounds.

In 1961 we are scheduled to launch our first Centaur. The Centaur will be the first vehicle to employ a high-energy upper stage, and this liquid hydrogen-liquid oxygen stage is the first to employ a rocket engine developed primarily for space use.

THE added energy afforded by hydrogen as a fuel gives the Centaur half again the payload of the Atlas-Agena B in a low orbit, and nearly three times as much payload when used as a lunar probe, which is one of its principal missions in the NASA program. In Centaur, the United States for the first time will have a launch vehicle able to duplicate the payload capability of the Sputnik vehicle.

The Centaur is of major interest to the Department of Defense as well as to NASA. In fact, the Centaur performance objectives originally stemmed from the DOD requirements for a 24-hour communications satellite. The importance of the Centaur to NASA, however, is much more far-reaching than the capability of the Centaur vehicle itself because of its relationship to Saturn. The Centaur upper stage will become the top stage for Saturn. In addition, four Centaur engines will power the second Saturn stage.

The Saturn vehicle is being developed under the management of Dr. Wernher von Braun's Marshall Space Flight Center. Its first stage consists of a cluster of eight uprated engines of the type used in the Thor, Jupiter, and Atlas with a total thrust of 1,500,000 pounds. On top of it we will use the two hydrogen-



oxygen stages mentioned above. When we get this Saturn C-1 vehicle, which is the initial version of Saturn, our payload capability gets a real king-sized boost—to some 25,000 pounds in a 300-mile orbit.

One, and possibly two, versions of Saturn are planned. The second model, called C-2, will add another stage using four 200,000-pound-thrust liquid oxygen-liquid hydrogen engines. The third model, if we decide to build it, will be called the C-3 and will have still another stage, using two of these 200,000-pound-thrust engines.

Some study and analysis has been conducted and a great deal more is planned to define the vehicle to follow the Saturn C-2. A major question these studies must answer is whether the successor to the C-2 should employ nuclear rockets in one or more stages or whether another all-chemical rocket vehicle will be required before the three-to-one advantage in payload-to-vehicle-weight ratio afforded by nuclear upper stages can be practically realized.

As to direction, the major long-range goal of the NASA program is manned exploration, first of the moon, then the nearer planets. This goal serves to focus attention on the vehicle-development program, the Mercury program, follow-on manned earth satellite programs, preliminary unmanned explorations of the lunar surface, the variation of the space environment between the earth and the moon, and on all the host of basic and applied research which must provide us with the information we need to realize this goal.

THE plan also projects the space sciences and satellite applications programs. As mentioned above, the space sciences program itself gains direction and emphasis from this objective of ultimate manned lunar and planetary exploration. Our satellite applications program will continue to develop improved means of microwave communications and improved means of forecasting weather through meteorological satellites.

To carry out these programs, NASA will launch between twenty-five and thirty-five major vehicles and at least this many sounding rockets annually over the next three years.

In summary, we are embarked upon a broad, technically sound and logical program with definite goals in mind—our own goals. We are undoubtedly going to have our share of failures in this program—they have to be expected in this kind of work—and we will undoubtedly have to adjust the detailed timing and content of the program as we move along and learn more. But we do have a plan, we are getting good support and cooperation.

The Disarmament Myth

Contrary to popular belief, nations are armed because they differ — they do not differ because they are armed, so in itself disarmament is not capable of promoting peace but can only be the outcome of it

Maj. Reginald Hargreaves

EVER since the end of the bloodthirsty Peloponnesian War in 404 B.C., mankind has been talking about disarmament or the limitation of armaments—and periodically plunging into strife. Unvarying for over two thousand years, such has been the systole and diastole of the human species' stumbling chronicle.

The Roman Empire was carved out by the sword; it murmured too often and too fondly of peace and ease, and was swept away by the sword of a barbarian invader.

In the world-twilight that ensued, petty tribal quarrels were resolved by weapons that had reverted to the most primitive types.

WITH the emergence of medievalism's ethnological groupings—they scarcely qualified as nations—the Christian Church, philosophically accepting warfare as being endemic in the human race, sought only to discourage its incidence and, when it did break out, to curb its worst excesses. With commendable realism the early theocrats unreservedly admitted that so long as a stake could be cut from the hedgerow or a stone snatched from the roadside, the ideal of total disarmament was no more than a flickering will-o'-the-wisp. Through religious sanctions and ordinances, therefore, papal authority strove diligently to restrict the number of lethal weapons in employment; to bring about, in effect, a deliberate limitation of armaments.

Major Hargreaves, a well-known historical writer, is a retired officer of the British Army. He is a frequent contributor to ORDNANCE *magazine and the author of several books including "The Narrow Seas" and "The Enemy at the Gate."*

Thus the introduction of the arbalest, or crossbow, into warfare during the course of the eleventh century brought almost immediate reaction. In A.D. 1139 the Second Lateran Council, with all the weight of its immense authority, sternly prohibited the arbalest's employment in war—solemnly denouncing it as "a weapon hateful to God and too murtherous for Christian men to use against one another."

The sponsors of Magna Carta fully supported the ban, one clause of the enactment specifically prohibiting the inclusion of crossbowmen amongst the English forces.

And everybody sat back and waited to see if his neighbor would set aside the weapon that had been brought so explicitly under interdict. In the outcome, since no one was prepared to act unilaterally lest he be caught at a disadvantage by a less scrupulous rival, the arbalest took its regular place amongst the Western world's standard armaments. It thereafter remained in use until the early days of the fourteenth century when it was very largely superseded by the even more deadly longbow.

Despite the tremendous authority wielded by the medieval Church, the first attempt on any considerable scale to bring about a hard-and-fast limitation of armaments had proved entirely ineffective. Its failure was entirely attributable to the widespread, and far from unwarranted, fear that someone would renege and secure an unfair advantage as the outcome of his duplicity.

THE earliest employment of gunpowder as a means of waging war evoked as shocked and as universal an outcry as the release of the first atomic bombs on Hiroshima and Nagasaki. For "this villainous saltpetre . . . digg'd out of the bowels of the harmless earth" not only effectively proletarianized armed conflict—since gunpowder "made all men alike tall"—but its use outraged every article of the chivalric code of war hitherto prevailing.

The most strenuous efforts were made to confine warfare's practice to the weapons heretofore regarded as admissible. Such contemporary paladins as Prospero Colonna and Gian Paolo Vitelli did not scruple to lop off the hands of captured cannoneers, mine layers, and siege engineers. Arquebusiers who had the misfortune to be taken prisoner by Bayard—the *Chevalier sans peur et sans reproche*—were either slain out of hand or had their eyes put out as "murtherers and unchristian fighters."

And in no uncertain voice the Church joined its anathema to the protests of those who perceived the infinite dangers inherent in this satanic enlargement of the means of destruction.

But once again no one could trust his neighbor not to secrete and subsequently employ a death-dealing substance he himself was prepared to forego.

With the massive walls of Constantinople reduced to rubble in forty days by the besiegers' cannoneers in 1453, and the first ship of war sunk by gunfire at Terceira in 1583, all attempts at the limitation of armaments by the voluntary elimination of what Ariosto termed "this base implement of death" had perforce to be abandoned.

But if the old ideas about warfare had been rendered obsolete, gunpowder, by its deadly potency, had generated a new regard for peace. Conflict, from being "a trial of moral values by battle in which the Church refereed for God," was replaced by a new concept—that of "war as a means toward a political end" and one only to be embarked upon, as a last resort, if that political end could not be obtained by negotiation and diplomacy.

Despite aberrations such as the frenzied, merciless "wars of religion" that raged between 1618 and 1648, this concept continued to hold the field until the outbreak of hostilities in Korea. This clash witnessed the first overt collision between two irreconcilable ideologies, and introduced warfare on a plane that, carried to its logical conclusion, rules out all compromise and predicates the annihilation or enslavement of the loser wherever victory may be achieved by the forces of Communist imperialism.

THROUGHOUT virtually the whole of the eighteenth century the world was kept in a state of belligerent turmoil by Gallic efforts to secure the hegemony of Europe and to outpace all her rivals —including a swiftly expanding Russia—in the consolidation of a colonial empire. It was a struggle that continued with ever-increasing ferocity until it met its predestined end on the sodden field of Waterloo.

But its progress had been marked by no outstanding enlargement of warfare's armory, no intensification of the killing-power of the weapons available. Cannon, although more mobile than in the days of their first introduction, differed little in design and lethal capability. To all practical intents and purposes the musket was of similar pattern to that employed against the French and Indians in "Queen Anne's War."

> *"A little coldly realistic reflection should make it abundantly clear that it is not so much armaments as inequality of armaments that puts a premium on war. As long as there is anything like parity between the armories of the major powers, war becomes far too great a hazard for anyone to embark upon other than the imbecile-hysteric or the irresponsibly desperate."*

Napoleon's banishment to Elba, however, found the world sour and sick and utterly weary of the whole idea of war as a means of settling international differences. So—at the outset—there was a ready ear for Tsar Alexander's proposal for a Holy Alliance which, while proclaiming Christianity to be "the foundation of all government and all civilization," went on to propose a drastic scaling down of armaments.

When, however, it was discovered that, reduced to essentials, the project was nothing more than an elaborate façade behind which imperial expansion could proceed at the expense of Russia's neighbors, Metternich dismissed the whole crafty artifice as "a loud-sounding nothing," and even the temperate, accommodating British Foreign Minister, Castlereagh, was fain to describe it as "a mixture of sublime mysticism and arrant absurdity." A pig in a poke remains a dubious bargain whatever the moral attitudes struck by its would-be vendor.

The lethal power of war devices sharply increased in the latter part of the nineteenth century, with far more powerful propellants and weapons of far greater range and precision. When the conflict of 1914-1918 saw the readoption of Dubois Crancy's damnable French revolutionary doctrine of harnessing the entire human and material resources of a country to the prosecution of "total" war, the particular climate of opinion that would characterize the immediate postwar years could clearly be envisaged.

Ravaged, disillusioned, and utterly war-weary as Europe was, the assembly of a Disarmament Commission at Geneva, under the auspices of that complacent monument of impotence, the League of Nations, was in the general philosophy of the time.

Initially, febrile hopes were entertained not only that the crushing burden represented by the need to maintain huge armaments would be substantially reduced, but that some means would be found of relieving the civil population of the dire consequences of unrestricted submarine and aerial warfare.

IT was at this juncture that Communist Russia's representative, Maxim Litvinoff, blandly put forward a proposal for the universal abolishment of *all* armed forces. It was a suggestion that provoked such bewildered embarrassment in the other Powers' delegates as to throw them into a state of hopeless confusion from which they never quite recovered.

Even a multilateral *reduction* in armaments was found, on examination, to be virtually impracticable, since no one could agree who was to disarm with what, and to what extent. Obviously an inland power such as Hungary would not require a navy. On the other hand maritime powers such as Britain and the United States, with overseas responsibilities and a numerous mercantile marine with a right to demand protection, could scarcely be expected to do without one.

And navies demand overseas refueling stations, which in turn have to be garrisoned with regular troops. Furthermore, with the wide differences in population totals it was quite impossible to agree on a mean average figure for the police forces required to maintain internal order in the respective countries, or to determine if, and how, they were to be armed.

Assured that he could look for vocif-

erous support from the messianic myopics the wide world over—utopians who invariably overestimate the power of human reason and underestimate the power of irrational forces—Litvinoff, tongue in cheek, kept the devil's brew of confusion on the boil by tirelessly reverting to his original theme.

It was the Spanish delegate, Salvador de Madariaga, who came nearest to deflating him when he regaled the Commission with the following shrewd little parable:

"THE story is told," the Spaniard suavely informed his colleagues, "of a conference of beasts that once discussed the question of disarmament. The lion spoke first, and looking at the eagle, suggested the abolition of wings. The eagle, turning to the bull, proposed doing away with horns. The bull, in his turn, regarded the tiger and demanded the elimination of claws. It remained for the bear to speak, and he proposed the abolition of every means of attack and defense, so that he might hug them closely in his loving embrace."

As it transpired, the only outcome of the interminable disarmament wrangle was the progressive military enfeeblement of Britain and France and the rearming of Hitler's Germany and Stalin's Russia.

And now the wheel has swung full circle with Khrushchev's disinterment of the proposal for total disarmament, to be carried out over a period of four years. With the appalling menace of nuclear warfare hanging like a thundercloud over the world, such a gambit is certain to enlist the support—heartfelt to the point of hysteria—of all those for whom peace is the longed-for objective, irrespective of the price that might have to be paid for it.

Fair-sounding as it may appear, it is entirely necessary coolly and objectively to examine the implications embodied in the Communist leader's proposition.

To begin with, multilateral disarmament is no more than an empty phrase unless arrangements are agreed upon for multilateral inspection. And there experience gained in seeking to ensure German disarmament after the 1914-1918 conflict is anything but encouraging. Despite the best efforts of the Allied Control Commission, some 4,000,000 rifles, 39,000 field guns, and a comparable number of machine guns remained unearthed. Even such conspicuous chunks of hardware as the huge railway gun which had shelled Paris at a range of eighty miles, and the famous "Big Bertha," the 15-inch naval gun that "told Dunkirk the time," contrived to elude discovery and dismantlement. So did the German General Staff, which carried on as heretofore discreetly camouflaged as the Land Survey and Geographical Department of the Ministry of the Interior.

In a naval sense it must be agreed that had the Germans, instead of surrendering their fleet, sought in some way to hide it, their task would have been virtually impossible. But since those days the emphasis has changed from the conspicuous battleship and battle cruiser to the submarine; and nothing is easier to conceal than a submersible. (It is highly significant that the Khrushchev proposal regarding disarmament should have immediately been followed by news of Russia's intention to scrap her SVERDLOV-class cruisers!) Similar aptitude for concealment applies to the intercontinental ballistic missile and the apparatus for its launching.

The appalling menace of nuclear warfare lends credence to the myth of multilateral disarmament (Marine Corps photo).

Furthermore, at what point does the man armed with the usual array of "conventional" weapons cease to be a soldier and become a policeman? Since Russia, like most other European countries, employs a paramilitary police force—in her case supported by armored cars and light tanks—disarmament, which would be compelled to allow some organization for internal security, would simply endow the Kremlin with the most numerous and powerful "conventional" force on the Continent.

Against the ordinary policeman with a truncheon, the man with a rifle would be at an enormous advantage—by whatever name he happened to be called.

The plain truth of the matter is that you cannot tinker with the question of disarmament. Partial disarmament—the best that could be hoped for as long as the need for internal security remained—simply begs the question. Like peace, disarmament is indivisible.

Nations are armed because they differ; they do not differ because they are armed. It follows that in itself disarmament can never promote peace, but can only be the outcome of it.

A little coldly realistic reflection should make it abundantly clear that it is not so much armaments as *inequality* of armaments that puts a premium on war. As long as there is anything like parity between the armories of the major powers, war becomes far too great a hazard for anyone to embark upon other than the imbecile-hysteric or the irresponsibly desperate.

IN effect, an even spread of armaments throughout the world permits that "maintenance of a just equilibrium between the members of the family of nations as should prevent any one of them becoming sufficiently strong to impose its will on the rest," which was Castlereagh's definition of what constitutes a safe and reliable balance of power. For while it is conceivable that the world's leading states could be

equally strong, it is entirely inconceivable that they could be equally weak.

"The Russians," Chester Wilmot has cogently pointed out, "regard international conferences as opportunities for the recognition of situations which have already been created by the exercise of power, not as the occasions for the negotiation of reasonable settlements, mutually acceptable." By employing the *ignis fatuus* of disarmament to delude the easily duped amongst his own people and those of the "uncommitted" nations into the belief that he honestly stands for peace, the Russian leader designs to place the onus for any disturbance of it fairly and squarely on the shoulders of the Western powers—even were they driven to take the field in sheer self-defense.

What appears to be insufficiently realized is that the Communist technique of diplomacy and negotiation differs almost completely from that practiced by Westerners. Trained to employ the devices of "double talk" and "double think," Russian negotiators are guided by a code that is fundamentally Oriental.

They *expect* their vis-à-vis to be on the lookout for an attempt to cheat him, and to react accordingly. Naïvely to accept anything at its face value earns the sort of contempt reserved by the bazaar carpet dealer for the customer who pays the first price he demands, without any attempt at bargaining.

Their word is their bond only on the rare occasions when abiding by it promises to pay a better dividend than dissimulation. Truth is an ace up the sleeve to be played only if its unexpected appearance will make sure of turning the trick. In normal circumstances it is carefully shielded by an eye-taking bodyguard of lies.

NIKITA Khrushchev is an individual who is quite prepared to reveal a lot about his aims in order to conceal more. There can, therefore, be no reproach attached to calling his sincerity in this particular into grave question. For no man could be more faithful than he to the fundamentals of Communist doctrine. And by them it was long since laid down that "any ruse, cunning, unlawful method, evasion, or concealment of the truth" is legitimate if employed to further the cause (Ref., "The Infantile Sickness of Leftism in Communism," by N. Lenin).

Leopards do not change their spots. The language may be encouraging, the attitude unexceptionable. But the purpose remains the same. That purpose was summarized once and for all in a brutally candid speech by the Kremlin mouthpiece, Dimitri Manuilsky.

Writing in the May-June 1960 issue of ORDNANCE *(Vol. XLIV, No. 240), Major Hargreaves said in an article entitled "Truce of the Bear":*

"Lenin early gave recognition to Marx's fundamental doctrine when he wrote: 'So long as capitalism and socialism exist, we cannot live in peace. We are left, therefore, with the prospect of a state of coexistence which means the absence of both peace and war in the full sense of both words, which may last for years and perhaps generations to come. A better name for this state of things would be coexistence with conflict.'

"It was upon this rationalization of the problem that the Party line was framed. For in 1938 Stalin, in his Communist decalogue, 'Leninism,' roundly affirmed: 'We are living, not merely in a state, but in a system of states, and it is inconceivable that the Soviet republic should continue to exist interminably side by side with imperialist states. Ultimately, one or the other must conquer. Pending this development, a number of terrible clashes between the Soviet republic and the bourgeois states must inevitably occur.'

"Since the frank exposé of concepts and intentions was penned, developments in nuclear physics, on both sides of the Iron Curtain, have counseled certain modifications in the Soviet methods of conducting a conflict which the Kremlin still pursues with unabated zeal.

"As both parties have come to realize, in any all-out 'hot' war the choice would lie between defeat and race suicide entailed in the employment of major nuclear weapons."

"WAR to the hilt between Communism and Capitalism," he declared, "is inevitable . . . Our time will come. To win we shall need the element of surprise. The bourgeoisie will have to be put to sleep. We shall begin by launching the most spectacular peace movement on record. There will be electrifying overtures and unheard-of concessions. The capitalist countries, stupid and decadent, will rejoice to cooperate in their own destruction. They will leap at another chance to be friends. As soon as their guard is down, we shall strike them with our clenched fist."

The "fist" could consist of the huge "conventional" forces retained, after "disarmament," under the guise of paramilitary police.

In the prevailing circumstances any proposal for disarmament—even for the limitation of armaments—is fraught with the most dangerous pitfalls. "The fox in his sleep dreams always of chickens," and the Communist, sleeping or waking, is obsessed with his dream of world conquest and the triumph of his loathsome creed. It follows that no confidence can be reposed in planned weakness. It is far better to rely on planned strength.

But regardless of this fundamental fact, on November 2, 1959, the United Nations' General Assembly's Political Committee unanimously adopted an 82-nation resolution calling for measures aimed at worldwide total disarmament "in the shortest possible time."

If the resolution was passed in the misguided belief that it would serve to stabilize world tranquillity then, in Franklin's immortal phrase, it was no more than "spitting in the wind."

The representatives' time would have been better occupied in the perusal of a little history—especially the writings of George Washington. For therein they might have come across the first President's unequivocal dictum: "The best method of preserving peace is to be prepared for war."

Pershing

A.O.A. Salutes the Career of the Commander in Chief of the A.E.F.

ON September 13, 1960, the United States will honor General of the Armies John J. Pershing on the centennial of his birth.

Forty years ago Pershing was the military symbol of the still-youthful United States which had sent millions of her sons overseas to "make the world safe for democracy" in the "war to end wars." Today the cynics and the beatniks may laugh at such naïveté, but the Nation then believed in its ideals and fought to continue its progress toward achieving them.

The early career of General Pershing was marked by frequent reassignments to widely varying duties. In the first fifteen years after his graduation from West Point in 1886 the young cavalryman had fought the Apaches, Sioux, and Crees in the West and the Spanish at Santiago; had been a professor of military science and tactics at the University of Nebraska; an assistant instructor of tactics at the Military Academy; had served three brief tours at the Headquarters of the Army; and served in Mindanao in the Philippines in both staff and command positions in the battles against the Moros.

BETWEEN his many staff and command assignments, Pershing attended the Army War College in late 1904 before proceeding to Japan as a military attaché, spending most of two years in Manchuria observing the Russo-Japanese War. At this time he was selected for promotion from captain to brigadier general in the Regular Army.

General Pershing received national recognition in 1916 as commander of the 10,000 men in the Mexican Punitive Expedition that broke up the revolutionary forces of Pancho Villa. In May 1917, President Wilson designated Pershing, a major general of eight months, to be the Commander in Chief of the American Expeditionary Forces, and he was promoted to the grade of general four months later.

Army photo

General of the Armies John J. Pershing
September 13, 1860—July 15, 1948

The tremendous capability, strength of mind, and determination of General Pershing were taxed to the utmost in the following months as the bantam Regular Army, with no field headquarters of division level or higher, was rapidly expanded to create the two-million-man A.E.F.

He was harassed by the problems of training recruits, utilizing foreign weapons and other ordnance, and establishing an unprecedented logistics system to supply the overwhelming output of the mobilized American industrial might which would sustain this force and the Allies.

Furthermore, he was under tremendous pressure from our Allies to use American soldiers as fillers for the tired French and English forces. With iron purpose, Pershing refused to deviate from the plan of an A.E.F. combat army as such until the German attack of March 1918 began to roll with such success that Pershing temporarily made his forces available without limitation to Marshal Foch to meet and overcome the crisis.

In September 1918, American troops moved into St.-Mihiel, and then into the Meuse-Argonne, and history was written. After the long build-up, the American troops forced the collapse of the tired German forces in two months. Pershing and the American position were vindicated.

In September 1919, Congress recreated the rank of General of the Armies in recognition of the distinguished performance of duty by General Pershing, the only person since George Washington to be accorded this honor. Two years later General Pershing became Chief of Staff of the United States Army. During his tenure of office great strides were made in developing the citizen Army and in reorganizing and expanding the system of military education.

PROBABLY his greatest contribution during this period was the modernization of the General Staff. While acknowledging the great difference in the needs of the then-isolationist country with a small army and those of today's leading free nation, with troops stationed around the world, one cannot overlook the contrast between Pershing's relatively simple organization and today's complex structure.

Upon his retirement for age in September 1924, General Pershing continued to serve his country on special missions for successive Presidents.

On July 15, 1948, General Pershing died at Walter Reed Army Hospital. He is buried on a knoll in Arlington National Cemetery where a simple headstone marks the grave of this great American soldier.

Airlift—The Weak Link

Although the U. S. has defense commitments around the world, the aircraft of our Military Air Transport Service average more than ten years of age and they are too few to meet all requirements

Lieut. Gen. Ira C. Eaker, U.S.A.F.

THERE is considerable evidence that our national leadership now means to repair what currently is the weakest link in our defense chain—the inadequacy of airlift. During the late days of the last session of Congress the Armed Services Committee of the House of Representatives, because of its grave concern about the obsolescence of the equipment of the Military Air Transport Service, appointed a subcommittee to hold hearings and review this situation.

The Hon. L. Mendel Rivers, able chairman of this subcommittee, promptly called upon the military leadership to present full and pertinent facts on the status of airlift to meet our military requirements.

THE testimony before the Rivers Committee, lately available, indicates clearly some glaring deficiencies in airlift availability to meet generally accepted war plans. The military leaders who testified before the Rivers Committee, representing all three services, seemed to agree with more than normal unanimity that inadequate airlift may be the withered arm or the club foot on our military posture today. Some of the Rivers Committee findings may be summarized as follows:

1. The MATS fleet of some 450 airplanes is nearing an average of 10 years of age; some of its planes were designed nearly 20 years ago!

2. There are only thirty-nine modern strategic airlift aircraft in the whole fleet. Eleven more are to be delivered. Only fifty are in prospect.

3. The Strategic Army Corps stands ready to move essential and initial elements within an hour. There is not enough airlift to move the Strategic Army Corps to either European or Far Eastern theaters of operation. There are great deficiencies in airlift availability for the movement of its essential weapons.

4. The military forces which would require airlift simultaneously in event of emergency include the Strategic Army Corps, airborne forces in Europe, airborne forces in the Pacific, maintenance crews and technical elements of the Strategic Air Command, maintenance crews and supporting forces of the Tactical Air Command, plus airborne elements of the Navy and Marine Corps. In event of limited war, two or three of these requirements might well develop simultaneously. In event of general war all of these forces would have simultaneous requirements for airlift support. MATS aircraft capability to meet all these requirements is now hopelessly inadequate even when reenforced by the airlift elements of the Tactical Air Command and by the addition of the civil reserve air fleet.

General Eaker, U.S.A.F. (Ret.) has a long and distinguished career in military aviation. A pioneer in the Army Air Corps, he climaxed his outstanding record as commander of the Eighth Air Force in Europe and later as Commander in Chief, Mediterranean Allied Air Forces, in the Second World War. In 1945 he became Chief of Staff, A.A.F. He is presently a vice-president of Douglas Aircraft Company with offices situated in Washington, D. C.

THE Rivers Committee was so impressed with the serious implications of the airlift shortage that Mr. Rivers appeared before the Appropriations Committee of the House and urged the addition of some $334,000,000 to the 1961 budget for the procurement of at least 50 airplanes of tactical airlift type, and 50 off-the-shelf jet cargo aircraft to meet strategic airlift requirements.

He also endorsed the allocation of $50,000,000 for the early initiation of research and development of a modern strategic airlift type. The Congress responded to his warning and advice by appropriating $250,000,000 of the $384,000,000 Mr. Rivers requested.

Military leaders, in their testimony before the Rivers Committee, pointed out that the requirements of modern war in the atomic era and missile age have tremendously increased the need for airlift in military operations. They also stressed the point that we have military alliances with some thirty other nations, and that these nations are almost entirely without airlift of their own. Their effectiveness as allies

can be greatly increased by the provision of American airlift.

A strange anomaly also was brought out by the testimony before the Rivers Committee. In any contest with our principal adversary, Russia, the latter has the distinct advantage of operating on interior lines of communication, whereas the United States must operate, by the chance of geography, on exterior lines. This means that the requirement for airlift by American forces is much greater and requires planes of considerably longer range.

Despite this geographic advantage for Russia, there is definite evidence that the Kremlin has placed greater emphasis on modernizing its air fleets than has the United States. There are several excellent cargo and personnel carriers now flying in Russia, both turboprop and turbojet, modern and adequate in every respect.

Mr. Rivers and members of his committee, after identifying the inadequacy of our airlift, made considerable effort to determine the reasons. Gen. Lyman Lemnitzer, the able Chief of Staff of the Army, expressed the view that the primary reason was due to budgetary considerations. He pointed out that both the Army and the Air Force expended all the funds allocated to them on what they considered to be higher-priority weapons systems.

Some members of the committee seemed to feel that airlift was in the unfortunate position of being everybody's business—and therefore nobody's business. It was a mission which the Air Force had to supply for the Army. It was suggested that if the Army had the airlift availability organically assigned to it, it would receive greater emphasis. General Lemnitzer did not agree that the Air Force slighted the airlift mission for lack of interest; he thought it was for lack of funds.

The first requirement to correct the airlift situation is, of course, a realization on the part of our national leadership of the tremendous importance of airlift in modern warfare. Thereafter, one may well inquire what steps can be taken to raise our airlift availability to our war-plans requirement.

There seems to be a general agreement between military and congressional leadership that the MATS fleets urgently need to be modernized. This can be accomplished by initiating without delay the design of new types of cargo aircraft. There must be a realization that at least two types are required, both tactical and strategic.

One serious mistake which might be made would be to endeavor to incorporate in one design all the diverse requirements of both the long-haul and the short-haul, the strategic and tactical types. The state of the art does not permit the design of one type of airplane to perform both tasks with optimum efficiency.

For example, the inclusion of air-drop characteristics in the long-range or strategic cargo jet automatically would add several thousand pounds to its weight, correspondingly reduce its cargo capacity, and reduce its speed at least 50 miles an hour. Its range also would suffer.

Testimony before the Rivers Committee indicated an urgent necessity to repair with minimum loss of time our deficiency in airlift. The quickest way to modernize MATS is to procure existing and available types at once. The Army testified that the C-130B and possibly the Canadian CL-44 would meet the requirements for tactical airlift. Similarly, there are at least two adequate types of strategic cargo jets available for procurement at an early date in the Douglas DC-8 and the Boeing 707 cargo versions. Each of these types, with minimum modifications, can be rolling off assembly lines in less than 2 years, and the initial 100-plane requirement could be delivered in less than 3 years.

Concurrently with this procurement of these available types, all the necessary steps for the design and engineering of new types for tactical and strategic airlift can proceed. It will take three to five years for the prototypes to be available and tested, and it will be an additional two to three years before planes of this type can be procured in the quantity needed.

Since it was generally agreed that budget considerations had been controlling in the failure to modernize MATS, this fact must have been overlooked by the national planners: one hundred modern jet cargo airplanes of types now available will do the work of the 450 planes now operated by the Military Air Transport Service.

MATS C-113 Cargomaster can airlift 50,000 pounds over 4,000 miles.

The new fleet of aircraft to modernize MATS, therefore, will pay for itself in savings—personnel, maintenance, and operational expenses—in less than five years. This valid conclusion flows from the fact that one modern cargo jet will do the work of five of the less efficient, obsolescent aircraft now in the MATS inventory.

Since it seems generally agreed that a modern airlift plane should be designed and tested as a matter of ur-

gency, a proposal by Senator Monroney, supported by General Quesada, is worthy of serious consideration. Senator Monroney, long known as Mr. Civil Aviation of the Senate, and General Quesada, able administrator of the Federal Aviation Agency, have introduced and sponsored an interesting idea. They have pointed out that the military will never be able to have in peacetime the full airlift requirement for war.

For that reason they propose the design and development of a cargo airplane for commercial use that would have an operating cost of four cents per ton-mile. They visualize that the availability of such an airplane will automatically lead to the growth of an air-cargo industry in this country comparable to the present status and stature of the passenger airlines. They envision with the availability of such an airplane a dramatic increase in the use of cargo aircraft which will have as an important by-product a tremendous growth influence on the whole national economy.

They suggest that within a few years there would be a requirement for at least 1,000 and perhaps several thousand such cargo aircraft, daily operated by civilian crews, which would be immediately available in event of emergency to augment the airlift in the Military Air Transport Service.

It is not alone lack of adequate funding for the procurement of cargo aircraft which is of vital concern. The lack of experimentation and research funds is important too. It is axiomatic that successful operations in warfare require the ultimate in speed. The military will be interested, therefore, in supersonic transport aircraft. This will enhance immeasurably the speed and effect of our announced retaliatory effort.

THERE are other interesting possibilities in the air-transport field which require attention and effort from the scientific and technical community. There are those who feel that battlefield supply may one day be done efficiently with rockets. Recently an Atlas missile delivered a warhead of several hundred pounds to a target 9,000 miles away. The Russians recently reported a rocket flight of their own of more than 8,000 miles. A considerable group of scientists in the National Aeronautics and Space Administration are now preoccupied with rocket experiments looking to a soft landing on the moon.

Strangely enough, no one seems to be spending enough effort toward the use of rockets in placing needed military cargo anywhere on earth.

Military leaders have well stated the requirement for airlift in our current war plans. They have pointed to our NATO, SEATO, and other alliances, indicating a definite and urgent requirement for airlift. They have pointed to the fact that our requirement for foreign bases makes airlift for supplies and air movement of SAC and TAC crews an urgent necessity.

There has been less stress on what may well be the most important mission required of airlift. Undoubtedly any nuclear attack on the United States would be followed immediately by the landing of enemy airborne forces. After nuclear attack, communications will be seriously interrupted and impaired.

In a matter of hours the Strategic Army Corps and the National Guard will need to be moved to many sections of the United States to deal with enemy airborne landings, and to reenforce the local police to prevent looting and restore order.

A PLAN, a budget, and a time schedule to meet our minimum airlift deficiencies might well be as follows:

1. Order immediately 100 cargo jets of existing types for strategic lift at a cost of $800,000,000.

2. Procure at once 50 tactical cargo planes of existing types at a cost of $200,000,000.

3. Initiate at once research, design, and tests of both tactical and strategic new types with civil cargo compatibility, at a cost over a 4-year period of $750,000,000.

4. Procure 100 each of these new types 5 to 8 years hence at a total cost of $1,500,000,000.

This over-all expenditure of some $3.25 billion is admittedly large, but it represents less than $400 million a year over an 8-year period. By comparison, our leaders plan to expend at least a billion dollars a year on our space ventures.

Our experiments in space are necessary and important, but they have not nearly the decisive impact on our chances of survival as does adequate airlift. We can and must afford all the weapons required for our survival.

"In any contest with our principal adversary, Russia, the latter has the distinct advantage of operating on interior lines of communication, whereas the United States must operate, by the chance of geography, on exterior lines. This means that the requirement for airlift by American forces is much greater and requires planes of considerably longer range.

"Despite this geographic advantage for Russia, there is definite evidence that the Kremlin has placed greater emphasis on modernizing its air fleets than has the United States. There are several excellent cargo and personnel carriers now flying in Russia, both turboprop and turbojet, modern and adequate in every respect . . .

"The first requirement to correct the airlift situation is, of course, a realization on the part of our national leadership of the tremendous importance of airlift in modern warfare. Thereafter, one may well inquire what steps can be taken to raise our airlift availability to our war-plans requirements.

"There seems to be a general agreement between military and congressional leadership that the MATS fleets urgently need to be modernized. This can be accomplished by initiating without delay the design of new types of cargo aircraft. There must be a realization that at least two types are required, both tactical and strategic.

"One serious mistake which might be made would be to endeavor to incorporate in one design all the diverse requirements of both the long-haul and the short-haul, the strategic and tactical types."

Make Weapons Simple

Our modern arms and equipment must be durable, reliable, easy to operate and to maintain, and reasonable in cost as well

Maj. Gen. Louis V. Hightower

General Hightower is the senior Army member of the Weapons Systems Evaluation Group, Office of the Director of Defense Research and Engineering, Washington, D. C. General Hightower recently addressed the Combat and Tactical Vehicle Division of the A.O.A. on the subject discussed here.

SINCE World War II a great deal of money, time, and effort have been expended on the development of combat vehicles for the Army. From a technical standpoint the user today has equipment with vastly increased capabilities over that used during World War II and Korea.

For example, weapons for our tanks have progressed from the inefficient 37- and 75-mm. guns on the M3 and M4 tanks to the extremely potent 105- and 120-mm. guns mounted on the M60 and M103 tanks. Cruising ranges of our combat vehicles have been increased in the last few years from less than 100 miles to well in excess of 200 miles, and in some cases to more than 300 miles.

Personnel carriers have gone from the relatively immobile, open-top, half-tracks to the highly mobile, fully armored M59 and M113. These latter vehicles now provide our infantry with excellent cross-country mobility and the capability of traversing inland waterways.

ARTILLERY has progressed from vehicle-drawn fieldpieces to highly mobile, self-propelled guns and missiles. But at what price have we gained these technical advances? Our equipment has become more complicated, more expensive, and less reliable and durable than the user requires. We shall discuss the evaluation of our combat vehicles against these criteria.

Down through the years, the user has repeatedly emphasized the requirement for increased reliability and durability in his combat vehicles. In addition, he has habitually requested that emphasis be placed on simplified maintenance and a reduction in time required for, and frequency of, maintenance operations.

Reliability is defined as the capability of trouble-free operation of an end item in accordance with its military characteristics without repair, adjustment, service, or replacement which are not preplanned as a part of normal maintenance service for the end item.

The user's goal for reliability has been stated as "a degree of reliability which would eliminate the requirement for adjustment and service between scheduled maintenance services." These scheduled maintenance services are now required every three months on both wheeled and tracked vehicles. In essence, then, what the user requires is vehicles that will meet this criterion without requiring any maintenance other than adding the necessary fuel, oil, and possibly some limited lubrication.

Durability, on the other hand, is defined as "the capability of an end item to perform according to its military characteristics during a certain period of time, or miles of operation, without failure or excessive wear beyond prescribed limits, of any part, assembly, or component, other than those which are preplanned as described by pertinent technical maintenance manuals as part of normal maintenance services of the end item."

The user's criterion in respect to durability is stated as follows: (1) For tracked combat vehicles—a degree of durability that will permit 2,000 miles or 200 hours of operation without requiring repair beyond the scope of organizational maintenance, or 4,000 miles or 400 hours before requiring rebuild. (2) For wheeled, tactical vehicles —a degree of durability that will permit 10,000 miles of operation without field maintenance and 20,000 miles without depot maintenance. Today, neither the reliability nor durability criterion is being met.

The user is concerned with this problem. Why? Let us review the results of a service test which was just completed on a new developmental combat vehicle.

This vehicle was operated across country and on secondary and improved roads for 3,178 miles, at which time the test was suspended to permit extensive modification. During this period of operation a total of 723 man-hours were expended in maintaining this vehicle—424 hours of which were nonscheduled. After modifications had been

applied to the vehicle, it was operated for an additional 1,987 miles. During this period, an additional 466 man-hours were expended on maintenance, 254 of which were nonscheduled.

In summarizing this test from a reliability and durability standpoint, we find that this vehicle was operated for a total of 5,165 miles and that 1,198-man-hours were expended in maintaining the vehicle, 678 man-hours of which were nonscheduled.

Of course, these maintenance requirements were excessive. In this instance, the vehicle required 2.26 man-hours of maintenance per hour of vehicle operation during the initial testing, and 2.65 man-hours of maintenance per hour of vehicle operation after modifications. Note the increase of 0.39 man-hour required after modification.

THIS is only one example of a developmental vehicle. Other current and developmental vehicles are not much better. As a result of a recent field survey conducted by Ordnance, it was determined that the best wheeled tactical vehicle had only a 42 per cent probability of surviving 20,000 miles and the best tracked combat vehicle had only a 3 per cent probability of surviving 4,000 miles.

Some samplings of this survey show the following results. The maintenance records of 272 tracked vehicles of one type were examined. These vehicles had operated for an average of only 1,551 miles, yet they had experienced 117 engine failures, 121 transmission failures, 10 final-drive and 10 major-suspension failures that required Ordnance maintenance.

Over 400 tracked vehicles of another type which had operated for an average of 2,087 miles listed the following major failures: 299 engines, 257 transmissions, 8 final drives, 53 major suspensions, 44 accessories, and 10 auxiliary generators. The average life in miles of these major components was on the order of 1,100 to 1,500 miles.

This lack of reliability and durability has a tremendous impact on the user. Maintenance of this magnitude requires vast numbers of mechanics to keep an acceptable number of the tactical unit's

"Regardless of improvements achieved in design simplicity, we will continue to have training requirements. We do not expect equipment to be so simple to operate that no training time will be required."

vehicles operational. This problem can be appreciated when we look at the table of organization and equipment of the tank battalion in the current Infantry division. This battalion has a total of 766 officers and men, and is equipped with 107 combat vehicles.

The startling thing about these figures is that of these 766 men, 103 are assigned to maintenance jobs of some types. This is a ratio of almost one man per combat vehicle. With this number of personnel we could man another tank company. Note that these men do nothing higher than second-echelon repairs.

In addition, we have the Ordnance battalions, signal repair teams, and countless others working at higher echelons to support these vehicles.

Such statistics are equally startling when compared with the reliability and durability of current commercial equipment. For example, there are many interstate trucking companies and bus lines that measure the life of components and vehicles in hundreds of thousands of miles and to whom breakdown on the road is intolerable.

These are the same kind of components and vehicles designed by the same engineers and manufactured by the same companies that develop and produce the components and military vehicles for the Army. Commercial vehicle design and operations have benefited greatly, in the past thirty years, from the vast improvement in roads which this country has enjoyed.

Unfortunately, the requirements for military vehicles operating in the battlefield environment are diametrically opposed to the criteria for vehicles operating in this commercial environment. In fact, the commercial and the military environments have become so widely divergent that the user cannot expect the development of satisfactory military vehicles to come about as a free by-product of normal progress in the commercial automotive industry.

Perhaps it would help if vehicle designers and producers recognized that a tremendous gap exists between the commercial and military environment and placed greater emphasis on environmental engineering. By environmental engineering is meant the responsibility of ensuring that the vehicle and its components will meet the expressed maintenance criteria in the field and under Army environment.

It is not enough that an engine perform well on a test stand or in a test vehicle under controlled conditions, or in a commercial application on superhighways. The commercial engine, for example, when installed in a military vehicle and operated in a battlefield environment, must be protected by more efficient air, oil, and fuel filters than required in the commercial environment.

We are not proposing abandonment of the use of commercial components. We are only highlighting the problem. The Army cannot afford to duplicate development costs and to amortize the costs of special tooling over short production runs. Industry must therefore undertake to develop ancillary protective devices to assure that commercially developed components will survive in the military environment.

INDUSTRY must continue to recognize the Army as the expert in matters affecting the military environment. With this relationship, we may expect a renaissance in such projects as: (1) Improvement of air-intake systems, crankcase breathers, oil and fuel filters; (2) development of sealed brakes and the application of retarders; (3) design of fail-safe and foolproof devices to prevent the destruction of expensive engines and transmissions; (4) incorporation of check-out and test features in systems and components; (5) application of prelubricated or self-lubricating assemblies, potted or sealed, to preclude tampering and developed for long, service-free life before being thrown away.

Another possible solution might be the implementation of a maintenance inspection system that will ensure that equipment meets the criteria, prior to

issue to the user. In this respect, a penalty might be imposed on the producer should these criteria not be met. For example, the producer could possibly be required to defray the cost of maintenance for a reasonable period of time after issue. This system works quite well in the commercial vehicle industry.

While the user is aware that avoidance of complexity through simple design may be possible, he is equally aware that many of his requirements do not lend themselves to simple design approaches. As a result, some of our equipment has necessarily become more complex. This is essential, in many cases, simply because we must be able to compete in the technological advances attained by any enemy.

As stated earlier, this same complexity is exacting increasing costs in time, personnel, and material to support the equipment once it is in the field. Our principle in considering simplicity of Army equipment is that complexity in design may be necessary but that the operation and maintenance of the equipment must be as simple as possible.

Let us look at some examples of past equipments that were somewhat difficult to operate and see what has been done to improve or correct these problems. Tank driving, during World War II, was quite an art. Through long training and experience some of our soldiers did finally master it. However, the constant-mesh and synchromesh transmissions left much to be desired.

THIS deficiency has been corrected in our current tanks by the use of automatic transmissions that are very easy to shift up and down, reverse, or pivot. Thus, from the requirement to manhandle the M4, design change has simplified the M48 and M60 driving controls to the extent that our wives can now operate them.

Another example is in the tank gunnery methods required then and today. With the M4, the tank commander was required to estimate the range to the target, relay this estimate to the gunner who would place the range line of his periscope reticule on the target.

Often the gunner was required to interpolate the range between these reference points on the reticule and was required to refer to a data card for some types of ammunition. As a result, the first round hit probability was low, particularly at the longer ranges, and far too much time was required to fire a complete problem.

Through the use of rangefinders and computers the art of gunnery, from a training and operational standpoint, has been simplified to the extent that the fire-control systems of our recent tanks will require only the following action:

The commander determines the range to the target by using his range-finder. Superelevation necessary to correct for the range is automatically transmitted to the gunner's sight reticule. All the gunner is required to do is place his sight reticule on the target and fire. The speed, accuracy, and simplicity of operating the new gunnery system more than compensates for the additional complexity of the equipment.

Simplicity of operation of equipment reduces training requirements—an important goal to consider in the design of equipment. No longer do wide oceans protect us from our enemies and give us time for preparation after hostilities begin. Every decrease in training requirements brought about through simplicity of design will help to compensate for our loss of build-up time.

It is true that, regardless of improvements achieved in design simplicity, we will continue to have training requirements. We do not expect equipment to be so simple to operate that no training time will be required. What is needed is a coordinated effort of increased efficiency of training and simplicity of equipment.

"As a result of a recent field survey conducted by Ordnance, it was determined that the best wheeled tactical vehicle had only a 42 per cent probability of surviving 20,000 miles and the best tracked combat vehicle had only a 3 per cent probability of surviving 4,000 miles."

The Army has embarked on a new training concept in the Reserve program, for example. In line with the "One Army" concept, the training standards of National Guard and Reserve units are now the same as for the active Army. Instead of the year of training necessary for Reserve units brought on active duty when the Korean action began, our Reserve forces must now be ready forces.

Because of the limited training time available to Reserve units, they cannot accomplish their mission unless the equipment is simple to operate and consequently requires a short training time.

Design simplicity also is essential from a maintenance standpoint. The present requirement for so many special tools and highly skilled technicians must be reduced.

In this respect the designer and producer must consider that any criterion in determining acceptable skill levels should be predicated on the native abilities of the population and not on the skill level an engineer would consider possible under field conditions.

THIS brings us to the final aspect of the equipment. Of course, there is a real limit to the funds available, and we will need more and more items of new and improved equipment to modernize our ground forces.

This may mean that new equipment will be less sophisticated and less perfect than desired, but we must emphasize those aspects of equipment that are essential to perform the required mission and omit those things that are marginal or "nice to have."

We stand to lose if the end piece of equipment wears out before it can be brought to bear against the enemy, breaks down at a critical moment, is too complicated to be operated and maintained by a fatigued, frightened youth of average or less intelligence, and, finally, is so costly that the country cannot afford to buy a sufficient quantity.

This, then, is the final requirement. In addition to being highly mobile and effective, equipment must be durable, reliable, simple to operate and maintain, and of reasonable cost.

Artillery Forward!

With guidons streaming and horses straining, the field batteries of the North and South presented a gallant picture as they galloped over rough terrain and wheeled their pieces into position for battle

Fairfax Downey

Colonel Downey, author of the recently published "Clash of Cavalry," is a well-known Civil War scholar.

This article is taken from a chapter of Colonel Downey's latest book which is due to appear this fall, and represents the second in a series of articles on Civil War matériel which ORDNANCE *will publish during the centennial of the War Between the States.*

WHEN the Confederates rolled rocks down the slopes of Lookout Mountain and Missionary Ridge upon an assaulting enemy, they were using an early form of artillery. From the force of gravity the catapult had taken over; then gunpowder and the cannon.

In the western battles of 1863, as for centuries before, men marched to the sound of the guns. Smoke billowed across Chickamauga Creek and curtained the Georgia woods.

From flaming muzzle or bursting shell it thickened the mist of the Battle above the Clouds where fieldguns fired down from the heights, as from towering battlements, and were answered by siege and light pieces from the valley.

THEY had come rumbling into action, those Blue and Gray batteries, a gallant sight behind their streaming guidons. One hundred and fifty-five officers and enlisted men, if they had their full quota, which they infrequently did. Captain, lieutenants, sergeants and corporals, cannoneers and drivers, buglers, guidon-bearer, and artificers. Four to six guns, twice as many caissons, and limbers for all. Behind lumbered battery wagons.

One hundred and fifteen horses, saddle and draft, carrying riders or keeping traces taut. Each 6-horse gun or caisson team pulled a weight running up to 3,800 pounds, including the ammunition and the cannoneers seated on the chests.

Miring mud and jutting underbrush seldom halted them. Through narrow forest trails they sped, men and horses whipped and battered by branches. They jolted over miserable roads, or vestiges thereof, or rough ground where there was no road at all.

The toughest going was ascending a mountain incline, drivers bent low over pommels and urging on their pairs, climbing like cats. Or sliding down the steep descents, with sturdy wheelers bracing back mightily against the breeching, and cannoneers crouching forward on the chests in dread of those crushing pounds of metal and wood behind them.

Finally the bugle blast for action sounded, trails were unhooked and dropped, unlimbered carriages whirled to the rear, and the guns spoke.

"They spoke a powerful language." Crews swarmed around them, ramming powder charge and projectile or fixed round into muzzles while the vent was thumbed lest smoldering grains from a previous load ignite the new one and blow off the rammer's arms. Cannoneers primed, gunners sighted.

"Fire!" and lanyards jerked, pieces leaped back in recoil, and shells soared through a wreath of flame and smoke to burst among the enemy. And there was none who manned the guns who would not echo that boast of the Pennsylvania battery: "In our eyes no branch of the service was equal to the artillery."

IN tones of thunder the Napoleons, the Parrotts, the 3-inch James and Ordnance rifles, and the howitzers spoke at Chickamauga and Chattanooga. For the North there had been cannon enough at the beginning. In 1861 the supply of smoothbore pieces, unlike that of small arms, had been adequate. Provision of artillery kept pace with batteries trained to man it through a war which was primarily the infantryman's —a war in which the Union Army was issued 7,892 cannon in contrast to more than 4,000,000 small arms.

By 1857 the Government had adopted the Napoleon, a bronze, smoothbore gun-howitzer, a 12-pounder (so called from the weight of the solid ball it fired). Named after the French Em-

peror, Napoleon III, this light fieldpiece (some 1,230 pounds) became the artillery work horse of the Civil War.

It lacked the range, accuracy, and penetrating power of the rifled cannon, but it stood unmatched for the type of warfare it met—for close fighting in the woods and for the defense of entrenched positions; above all for the lethal blasts of canister, single, double, and triple charges, it delivered at ranges descending from 600 yards to point-blank.

Tredegar and other Confederate foundries began turning out Napoleons on the designs of former U. S. Ordnance officers who had joined the South. Those products, however, were inferior to the Northern-made, battlefield captures of which were eagerly sought. Through such trophies, arsenal seizures, and manufacture the Confederacy kept comparatively well supplied. It was the increasing shortage of horses for the teams that was finally crippling.

APPROVAL of Napoleons by artillerymen and the high command of both sides carried through the war. A gunner in Lumsden's Confederate battery remarked that the Yankees boasted that "with their 3-inch rifles they could hit the top of a barrel at a mile. But just let them get within a thousand yards, and we'll outshoot them every time with our Napoleons."

In General Grant's reorganization of the Army in March 1864, numbers of batteries armed with rifled cannon were issued Napoleons in their place.

Along with the Napoleons rolled other makes and calibers whose variety was exceeded only by that of shoulder and handguns. Many a battery was armed with two types, the disadvantage of carrying the two sorts of ammunition somewhat countered by the opportunity to use one type of gun or the other in a mission for which it was better suited.

As to the complexity of armaments, Birkhimer observes that "the field artillery with Rosecrans' army, February 8, 1863, was made up of thirty-two 6-pounder smoothbores, twenty-four 12-pounder howitzers, eight 12-pounder smoothbores, twenty-one James rifles, thirty-four 10-pounder Parrotts, two 12-pounder Wiard steel guns, two 6-pounder Wiard steel guns, two 16-pounder Parrotts, and four 3-inch Ordnance guns."

Smoothbores were making their last bow, though an impressive one. The day of the rifled cannon had dawned.

In striking array the rifled pieces stand today with the smoothbores in the National Military Park in the positions where they were fought almost a hundred years ago. Two or three batteries here, a 2-gun section or single cannon there—in woods, on a plateau, or frowning down from summits. You can sight along their barrels toward where their targets lay and visualize the circumstances when the iron or steel rifles dropped their shells at a distance and with a precision the Napoleons could not equal.

There stand the Parrotts with their characteristic iron jackets shrunk on over the breech, giving them their sturdiness—Parrotts that had poured forth from the West Point foundry—the 10- and 20-pounder fieldpieces, the 30-pounder siege guns. Yonder are ranked trim 3-inch Ordnance rifles (sometimes called Rodmans), always effective but especially favored by horse artillery, and 6-pounder guns and 12-pounder howitzers lift their now mute muzzles.

Ghostly cannoneers seem to pat the stubby barrels of the 12- and 24-pound howitzers. Smoothbores like the Napoleon but not as popular and of shorter range, their charges of spherical case (shrapnel) and canister were nonetheless deadly within their limits. Crews were fond of them because of their light weight, one-third less than the Emperor's namesakes. With tired artillerymen it counted to have a lighter piece to manhandle into a position which teams could not reach or to an exposed spot where the horses would have been vulnerable to enemy fire.

AT Chickamauga are now emplaced two of the four mountain howitzers which comprised part of the armament of Capt. Eli Lilly's 18th Indiana Battery. Officers who observed their fire in that battle were convinced of their effectiveness at short range. Models of 1837 or 1841, those short-barreled pieces had been employed in the Mexican and Indian wars. Light (the tube weighed only 220 pounds and the carriage 180), they could be drawn on wheels or disassembled and packed on mules or horses.

Muleback transportation sometimes gave trouble as in the case of a mountain battery with Jackson at Port Republic. The long-eared carriers rolled on the ground to rid themselves of their loads, and gunners were more occupied with controlling them than delivering fire on the enemy. Derisive infantrymen asked whether the guns were to fire the mules or the mules the guns!

Lilly's wheeled howitzers were not in action during the mountain fighting around Chattanooga. Disuse of those on hand, under conditions for which they were developed (along with failure to provide more), is as strange as the neglect of machine guns. Though their

The famous Battery D, 2nd U. S. Artillery, in action at Fredericksburg, 1863.

range at 5 degrees of elevation was only 900 yards, their transportability was a matter of first import. There were points on Lookout and Missionary Ridge where they could have served most efficiently and where they could have been put in positions defying placement of heavier pieces, just as Grant and his men had heaved one up into a Mexico City belfry.

Canister blasts from a battery of mountain "hows," had they been included in escorts of the Union wagon trains, could have handily beaten off some of the damaging raids of Joe Wheeler's Gray cavalry.

But though mountain howitzers were lacking on the heights, there were artillerymen like that crack gunner officer, Col. E. Porter Alexander, C.S.A., who ingeniously handled the cannon they had. Alexander, who had come west with Longstreet, stationed his battalion on Lookout and fought daily with a "vicious little battery on Moccasin Point, almost directly under us. This battery had nearly buried itself in the ground under high parapets, and fired up at us like a man shooting at a squirrel in a tree. We propped our trails high up in the air to depress the muzzles, and tried to smash our opponents into the earth with solid shot and percussion shell; but we never hurt them much, and when we left the mountain, they were still as lively as ever" (Alexander, "Memoirs of a Confederate," p. 746).

ALSO at Chattanooga and again at Knoxville, Alexander rigged four howitzers as mortars to drop shells behind parapets and search out spaces sheltered from direct fire. "To accomplish this, skids were prepared inclined at an angle of forty-five degrees, one end resting on the ground and the other on a horizontal pole supported about six feet from the ground on forked posts. The axle of the howitzer was run up on these skids, raising the wheels in the air on each side of the skids, and leaving the trail on the ground between them, until the pieces had an elevation of about sixty degrees."

With the range regulated by the amount of powder used (changes had to be diminished at high elevations), the system worked nicely and gave very fair mortar practice, the colonel declared.

Seen through a poet's eyes, the guns took on attributes their crews sensed though few could express them. War Correspondent Taylor, scanning the array of ordnance at Chattanooga, wrote:

"There are Parrotts with their long, black shafts, reenforced at the breech, like a trooper's trousers. There are bright Napoleons brisk and spiteful. . . . Here is a sturdy fellow that growled at Stone River; there a grim one that roared at Shiloh; yonder, a Columbiad made at Memphis. Do you see those pairs of immense wheels? They are not mill-wheels, but only the carriages of siege guns."

Here and there on the battlefields, companioning the guns, rise little black pyramids of the round shot that fed them. They mark the headquarters of generals or spots where they were killed or mortally wounded. Greater tokens of artillery's might are the shells and their fuzes—percussion and time, the latter cut to explode the projectile in flight at a desired moment.

Look at the shell Henry Shrapnel of the Royal Artillery devised as early as 1784 and you can imagine the death and destruction its cone of scattering balls spewed forth when it burst over a target. Through the Civil War it was called spherical case; later it bore its inventor's name.

Deadly, too, was the fragmentation of other types of shells, and deadliest of all at close range were the shotgunlike blasts of canister balls.

"A battery seen is a battery lost," ran a maxim of the First World War. Enemy observers, directing the fire of cannon with improved range, precision, and mechanism, could by instant communications from their posts launch a salvo of shells at a fleeting target and smash it.

In the Civil War, batteries seldom went unseen, although they took concealment when they could in the edge of woods or behind crests. Sometimes they were dug in, protected by parapets. Far more often they fought in the open, firing over the heads of their infantry or frequently in line with them or ahead of them.

Indirect fire, that is fire on a target unseen from the gun, with sights laid on an aiming stake and angles calculated therefrom, was little used in the 1860's.

Crews manned cannon lacking the gun shields and aprons of latter days. Every man was exposed, especially the swabbers and loaders who had to run to muzzles and turn their backs on the attacking enemy. Artillery's only defenses were such supporting infantry as it might have and its own mobility. Batteries could call up the limbers and shift position or retreat, providing that all the horses were not shot down in the maneuver.

EVEN with most of a 6-horse team dead or crippled and cut out of the traces, there is record of two or even one of the surviving animals gallantly managing to pull the gun to safety. With all horses gone, cannoneers time and again dragged the pieces back by prolonge ropes, halting to slam a round into pressing pursuit, then hauling the guns back again as they recoiled.

Overrun by an assault before they could escape, valiant artillerymen fought it out in the battery position. Officers and sergeants might swing sabers. Those lucky enough to have revolvers blazed away. Cannoneers jabbed and flailed with the only weapons they usually had—rammer staffs and trail handspikes.

Stone's River, Chickamauga, Lookout Mountain, and Missionary Ridge—like many another battle of the war—all saw desperate stands by Blue or Gray artillery around cherished pieces they would count it a disgrace to lose. Not until Korea would as much close combat be waged among the guns.

IN truth mighty feats of arms are recalled by the cannon in the Chickamauga-Chattanooga National Military Park and by the bronze bas-reliefs of artillery in action on their battery monuments. They stand silent but no less eloquent, whether they mount their perpetual guard in the Georgia woods or in the small reservations on Tennessee heights.

It was a proud thing to have manned the guns.

Defense Highlights: Monthly Review and Outlook

• **Asroc Becomes Operational.**—Asroc, the Navy's latest antisubmarine warfare weapon pictured on the front cover of this issue, is a long jump ahead compared with its predecessor—Weapon Alfa, a rocket-launched depth charge. Asroc is rocket-propelled from a surface ship launcher, arches into the air, drops its rocket motor, then opens a casing to release a parachute and lower a torpedo or a depth charge. It has been declared operational.

In recent tests Asroc's payload was a Mk. 44 homing torpedo, and it scored hits on the target submarine U.S.S. SKATE at 2,500 and 4,000 yards' range. The maximum range is believed to be six to eight miles.

The complete weapon system consists of a new sonar, a digital fire-control computer, an 8-tube launcher, and the missiles. It is being installed now in the destroyer leader NORFOLK (DL-1) and is scheduled to go in about ten more DL's, a few cruisers, and many of the destroyers undergoing modernization.

Known specifications are: length, 15 feet; diameter, 2½ feet over all; weight, about 1,000 pounds; developed by Naval Ordnance Test Station; prime contractor, Minneapolis-Honeywell Regulator Company.

Although other advanced ASW weapons such as Subroc, Astor, and Aster are under development, Asroc has many years of usefulness since its range can be increased and its payload made more potent as new torpedoes are developed.

• **Problems Plague ICBM Launching Sites.**—Intercontinental ballistic missile launching site construction has proved to be more complex than foreseen. Difficulties had been brewing for several months before they burst into public view with the announcement that the first Atlas bases would be delayed about five months—yet the Atlas missile itself is operational and rolling off the production line. The Air Force has had the problem under study since mid-1959. It has now reorganized management for base construction—with an assist from the Army.

Basic causes for the delay are evident in the cures that have been ordered. The Army's Corps of Engineers, responsible for the basic construction, have established the Ballistic Missile Construction Office in Los Angeles under Brig. Gen. A. C. Welling to assume tasks formerly directed by the smaller Los Angeles Engineer Field Office. His main office will have a greatly increased staff to work closely with the Air Force and to direct the efforts of about sixty Corps of Engineer officers at the sites.

The Air Force has shifted responsibility for site activation from the Air Research and Development Command to the Air Matériel Command and appointed Maj. Gen. T. P. Gerrity as chief of the Ballistic Missile Center, Inglewood, Calif., which is being expanded.

General Gerrity immediately assigned a site commander to each of the twelve bases for which he is responsible. These officers are authorized to cut across Air Force command lines to ensure that construction, installation, and check-out of all ground equipment are not delayed.

The sites for which construction commanders have been assigned by BMC, some for Atlas, some for Titan missiles (all well publicized) are located at the following Air Force Bases: Fairchild, Wash.; Walker, N. Mex.; Forbes, Kans.; Schilling, Kans.; Altus, Okla.; Dyess, Tex.; Plattsburgh, N. Y.; Larson, Wash.; Beale, Calif.; Ellsworth, S. Dak.; Mountain Home, Idaho; and Lowry, Colo.

ARDC, through its Ballistic Missile Division, will remain responsible for activating the first three sites on the schedule at Vandenberg AFB, Calif., Warren AFB, Wyo., and Offutt AFB, Nebr. It will also remain responsible for all site selections, installation design, and technical engineering, working closely with Army Engineers to ensure that construction materials and tolerances are compatible with the missile system and that a site is operational before it is turned over to the Strategic Air Command.

Besides hazy command relations, difficulties were increased by unsatisfactory contracting methods, frequent change orders to match progress of the state of the art, and—in Omaha—two months of freezing weather. Man-hours also were lost by jurisdictional strikes on the scene and a nationwide strike at Convair, the principal missile contractor.

One difficulty that has not been removed is the divergence in appropriation and contract procedures for missiles and for launching sites. Missiles are glamourous weapons with almost lump-sum funding and negotiated contracts with capable corporations. Launching sites and base construction are concrete and steel, and the Budget Bureau and Congress must examine every yard of concrete—a time-wasting process.

The lowest bidder gets the job—even if he is merely a construction "broker" who parcels it out to a babel of subcontractors and may not have the supervisory talent to coordinate the work. The prime contractor for developing and installing the launchers and intricate check-out equipment gets the blame for delays.

• **Polaris Zooms Ahead.**—With Polaris meeting all expectations and well ahead of earlier schedules the Navy is pressing to go all out for a second generation of its fleet ballistic missile. It is now seeking funds for development of type A3 to have a 2,500-mile range that will triple the ocean area from which the Polaris can be launched effectively to about 9 million square miles. The present A1 type is rated at 1,200 miles, and by 1962 the A2 Polaris will be ready with a range of 1,500 miles.

Advanced types of Polaris will be scheduled into the sub-

marine building program so that complete weapons systems will not be delayed. Presently there are 14 Polaris-launching submarines either in commission (2), building (7), or scheduled for construction (5), including 3 already awarded to private yards under the 1961 appropriation bill.

• **Nonpolitical Missile.**—Admiral Raborn—when asked if his recent successful Polaris shots were aimed at the Communists or the Democrats—replied, "The schedule of events was made two years ago. At that time, as today, the Navy loved both Democrats and Republicans!"

• **Weapons of the Future.**—Beyond the field of the development of weapons lies a fantastic area of dreaming up weapons of the future. These are the sort of weapons and fighting equipment we would like to have ten or fifteen years from now and for which we have not yet attained the necessary scientific and engineering knowledge.

For example, we seek a nuclear or other direct-energy device to propel our space vehicles for reconnaissance after they are launched into orbit. Presently such a device requires more effective heat- and pressure-resistant materials.

We need a means to stop missiles or at least inactivate their warheads without endangering populated areas. This problem awaits unforeseeable advances, probably in controlled high-frequency beams or in unbelievably high speed antimissiles.

The Marines want a large troop-carrying vehicle that can make high speed on land or sea and revolutionize amphibious warfare. For this the necessary lightweight engines and the appropriate hull structures are not in sight.

An existing example of scientific and engineering magic is the project for a helicopter that, once aloft, can be kept up there by power received from the ground by electronic devices. This program, on which Raytheon has spent a great deal of its own funds, is now receiving support from the Defense Department.

Some of these goals may seem impossible, yet all but a few laughed at the early rocket experiments of Dr. Robert H. Goddard. However, the rocket principles he developed are the basis for present capabilities. Now fifteen years after his death the Guggenheim Foundation that supported his efforts has been awarded $1 million by the Government as a lump-sum settlement for about two hundred patent infringements. All three services and the National Aeronautics and Space Administration paid a share of the settlement.

• **Item.**—There is no limit to what can be accomplished if it doesn't matter who gets the credit.—Anon.

• **Satellite Screen Planned.**—The Army Ordnance Ballistic Research Laboratories at Aberdeen Proving Ground are reported to have the high spot in considerations for a satellite-detection screen in the United States. They are especially qualified in detecting "dark" or nontransmitting satellites with their Doploc system.

The present single test facility with a radar transmitter at Fort Sill, Okla., and "detector" at Forest City, Ark., first located and identified the "mystery satellite" that proved to be part of our Discoverer V. The key to the system is the complex of high-speed computers at BRL to analyze the data transmitted from Forest City.

• **To the Polls, Men!**—One vote—yours—might be decisive. We aren't advising who you should vote for in the coming national election—just vote. One vote saved the draft before Pearl Harbor!

Sixty-two million Americans voted in the 1956 presidential election. Looks good? There were 40,000,000 unused ballots—only 60.2 per cent of our elegible citizens voted! Sixteen other non-Communist countries do better including: Austria, 95 per cent; Greece, 85 per cent; Japan, 73 per cent; and Canada, 67 per cent.

"All that is necessary for the forces of evil to win in the world is for good men to do nothing," as Edmund Burke said.

• **Atomic Test Ban Should Be Banned.**—Our self-imposed ban on testing nuclear weapons is viewed with increasing alarm by many officials of the Atomic Energy Commission and the Defense Department. Scientists in our laboratories are understood to have devised many weapon improvements, such as warhead clusters for ICBM's, that await testing to confirm their efficacy. Two years have passed since our last tests while frustrating wrangles continue in Geneva in deference to questionable psychological advantages in international dealings while our atomic weapons become outmoded.

Many of these officials are reported to believe that our national security demands resumption of tests, which could be scaled and carried out underground, for improved warheads, antimissile weapons, and low-yield tactical weapons.

On another front AEC has released the yield and altitude figures for 98 tests (keeping 70 secret), from the Bravo shot of 15 megatons, equivalent to 15 million tons of TNT, down to a 0.15-ton shot on October 30, 1958. The Commission has requested seismologists to correlate these explosions with their graphic records in order to expand the data on the possibility of spotting underground atomic tests.

• **Missile Responsibilities Realigned.**—Maj. Gen. August Schomburg, commanding general, Army Ordnance Missile Command, has reoriented the responsibilities of his subordinate agencies. The Army Ballistic Missile Agency has taken over from the Army Rocket and Guided Missile Agency all research, development, and industrial relations in connection with Honest John, Little John, Corporal, Sergeant, the light antitank weapon (LAW), and Missile A and B weapons systems and the necessary personnel.

ABMA will continue in charge of the Redstone, Jupiter, and Pershing missile programs, thus giving it all the Army missiles with fixed trajectories. ARGMA is left with the missiles that can be redirected in flight which include Lacrosse, Shillelagh, and all the surface-to-air missiles—Hawk, Mauler, Nike Zeus, Nike Hercules, Nike Ajax, and Redeye.

The Times Demand All-Out Preparedness

An Editorial

THE Executive branch of the Government, primarily the President and the Department of Defense, has made a strong effort to explain to all American citizens the extent of the military strength of the United States. The explanations have been in unusual detail to prove that we possess flexible and powerful retaliatory forces.

These revelations were outlined in the article entitled "Our Defense Posture" in the July-August issue of ORDNANCE based on statements and talks of Defense officials. However, the figures given were almost entirely related to the strength of our deterrent forces—our ability to retaliate with devastating effect. They touched lightly on our means to conduct a war of limited objectives; that is, any conflict less than a world war with big nuclear weapons.

Americans can accept the adequacy of our retaliatory forces under present conditions, and as the Soviets have made no overt moves with their own forces outside the Iron Curtain we assume that they are deterred by the evidence of destructive power in the hands of the United States and its allies.

Most of the criticism of our retaliatory forces has come from men who have not had all the facts or who were pleading a special interest. However, in the area of wars of limited objectives, where Defense officials have not been specific, the criticisms have had more validity and there is more widespread concern over limited war because of the feeling that the major powers have reached a nuclear war stalemate.

These critics have observed that there have been since World War II some fifteen to seventeen small wars of varying proportions—wars that our deterrent forces did not deter. The limited-war tactic of the Communists has been to prod and then retire or to push harder, depending upon the reaction, never pressing to the extent of exciting retaliation, except perhaps in Korea. Such a war can erupt with little warning.

Although there is great hue and cry over lack of a national policy and of cooperation between the Departments of Defense and State, we do have a national policy on combating local wars. This policy stems from our agreements with about forty countries to come to their aid if they are attacked or threatened from outside their territory.

To confirm this policy we point to the units of our armed forces scattered throughout the world and their support in our own country. Our objective is to prevent limited aggression from growing into a large war by prompt military reaction.

In spite of this policy and our international agreements, there are strong influences in the Government that have forced the spending for retaliatory weapons to the detriment of our armaments for limited war—some authorities going so far as to propound that the existence of our retaliatory forces should also deter small wars.

Any examination of the question of our capability to fight limited wars is restricted by classified matters such as exact tables of equipment and the localities where military staffs foresee trouble. However, plentiful material for a critique is furnished in the information broadcast to all the world and in the previous actions in which we have been engaged.

It is in our past local actions that we seem to have failed to learn our lessons. Korea is a tragic case in point. It was evident from our experience in Korea that we needed well-balanced, extremely mobile forces to offset possible conflict. If we had had the ability at that time to rush in two divisions and strong air and naval forces, that conflict probably could have been stopped early and without the great losses that we suffered.

Since that war, the need has been expressed by our highest authorities for trained mobile forces ready to intervene immediately to avert or counter any local conflict. Yet this requirement has not been met for an action equal in extent to our Korean embroilment. We may have the trained manpower but not the airlift. If larger masses of troops than in Korea were thrown suddenly against one of our small allies, the initial operations again could be disastrous for us.

Our authorities point with great pride to our reaction to the crisis in Lebanon. Fortunately, this was a minor affair. Three battalions of Marines were in the area, and the Sixth Fleet aircraft carriers rushed to the scene to give air support and were joined by other ships for logistic support. To back up the Marines, C-124 transports were flown from continental United States to Germany to pick up 1,700 airborne troops of our 24th Division, and aircraft of the Tactical Air Command flew to Adana, Turkey, from United States bases.

It was all effective for the occasion, but watchful reporters noted that our airlift was strained to the limits and that the backup forces did not arrive as promptly as desirable. Furthermore, we reduced our forces in Germany and appeared to be short of sufficient airlift to replace them from the United States in a hurry.

LIMITED-war capability—the need to counter a geographically restricted move—is conceived initially to involve a ground action, possibly with air support, and perhaps submarine and sea-mine warfare. We should examine the forces available in the face of an action of the scale of Korea and the possibility of several concurrent actions in separated areas, remembering that in many places we cannot expect much help from our local allies.

Our land force of fourteen Army and three Marine divisions seems woefully small compared with the number of fully equipped Communist divisions and in the face of our widespread commitments. We do have almost equal manpower if our allies are included, but there is not the homogeneity of command or of weapons. Our allies, leaning heav-

ily on the military power the United States evinced in World War II, may be leaning on a weak reed when we consider our Army equipment.

The Army has been bravely announcing that its eight divisions overseas and three in the Strategic Army Corps are well-trained and equipped and ready to help defend our allies overseas or rush to a "brush-fire" outbreak. It is quiet about the other three divisions that are usually in a state of flux and overburdened with basic training of new men.

Generals Ridgway, Gavin, and Taylor, unable to obtain support for adequate Army strength, retired early, in disgust. But at last our legislators have been aroused. They have brought out the fact that many weapons which have passed the development stage are not being produced in necessary quantities. For example, M14 rifles, M60 medium tanks, M113 armored personnel carriers, self-propelled artillery, modern helicopters, Hawk, Redeye, and Davy Crockett missiles.

These weapons are to replace World War II designs except in helicopters and missiles—and the Congress has published evidence that in all categories Soviet divisions are already rearmed with modern weapons more effective than ours.

IN looking back over the manpower record we see that four years ago Army personnel numbered 1.1 million. In 1958 it was cut to 900,000 and from 18 to 15 divisions. Now it is at 870,000 and 14 divisions. The excuse was that our economy couldn't afford both manpower and missiles; besides it wouldn't really weaken our defense because of the tremendous increase in firepower and mobility.

Congress at last has shown considerable skepticism to this theory since so little of the means to give us increased firepower has been put into production. This finding led our legislators to add $116 million for the Army's weapon budget.

In their examinations of military mobility the most damning indifference was exposed by Congress, particularly by the Special House Subcommittee on Airlift under Hon. L. Mendel Rivers. In the hearings, a top Defense Department witness claimed, as others have for over seven years, that "airlift is marginally capable of meeting wartime requirements under present plans." This included the Civil Reserve Air Fleet, a truly marginal adjunct, to say the least, in that it is embroiled in contractual arrangements.

The hearings made it evident that in both numbers and quality military airlift was inadequate and that in a limited war it would take at least ten days to fly in only one airborne division, lightly equipped—provided no other service had similar requirements.

In any war it appears that if the Strategic and Tactical Air Commands were involved they would need almost all MATS resources. Since airlift is a vital part of this country's limited-war capability it is disturbing to see the gross neglect it always has suffered while all the Defense Establishment except the Army has covered up behind the statement, "it meets the criteria established by the Joint Chiefs of Staff."

So this year's Defense Department budget originally carried $50 million to start a prototype cargo plane development while our meager supply of limited-range MATS aircraft were obsolescing rapidly. To relieve this situation, Congress has appropriated an additional $200 million.

Our naval forces are dwindling numerically to a dangerous point. New carriers, destroyers, and submarines are individually more effective fighting units than their World War II predecessors, but as the Navy has dropped from 1,030 active ships in 1955 to 817 this year it faces the same problem as the Army in meeting worldwide commitments with fewer and fewer numbers.

Further reduction of the Navy, as pointed out by its Chief, will mean that we could not give adequate naval support to limited war in two oceans for plain lack of numerical strength—a lack of ships that cannot be built on short notice.

In an over-all commentary on the steady reductions in the quantity of both manpower and fighting equipment in all three services, it must be discouraging to the military planners, faced each year with these reductions supposedly "to keep within the budget," to observe the Nation's continued growth in all other areas. While our population has increased by 28 million and gross national product has expanded by billions of dollars, our military manpower has been decreased over one million and the defense budget increased very little. It appears arithmetically that our defenses are becoming relatively weaker!

One explanation of the foregoing inconsistency is that there is great waste in defense spending. In fact the Congress has flailed out blindly at the Defense Department by cutting all procurement appropriations three per cent to enforce an improvement in contractual practices. In the meantime the do-gooders insist on placing defense work in economically depressed, less proficient areas.

Many theoretical economists—and some officials in high places—would eliminate all arsenals, ordnance plants, and personnel service activities. They overlook the need to maintain such functions in peacetime as they must be ready instantly if war breaks out. There are areas of excessive expenditures in pushing projects of questionable value beyond the development stage (over $1.6 billion has been spent on missile projects that later were canceled).

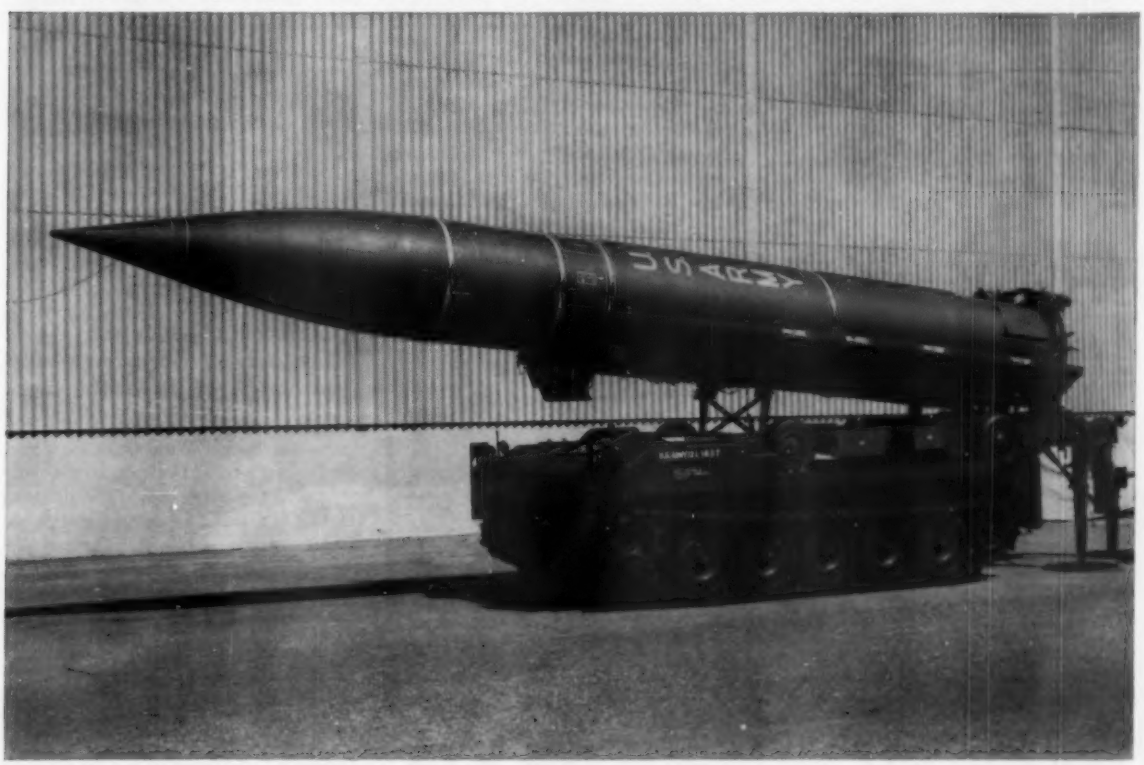
There also must be wasted dollars in a personnel system that allows Pentagon numbers to grow and grow while the military forces are cut. Fewer Indians and more chiefs doesn't make sense!

DEFENSE money can be spent more wisely in many areas. It is definitely possible—if politicians, "empire builders," and special-interest groups would cooperate—to get more defense for the dollar. However, as several of the country's more level-headed economists point out, the United States can afford whatever is necessary for defense.

Our history shows that a strong and factual appeal by our leaders will bring willing cooperation from our citizens to give us a complete defense. We need a combat potential of such a nature that it will make limited war as unprofitable to an enemy as we believe we have made all-out war.

Pershing Moves Up and Away

The Pershing selective combat range artillery missile, shown blasting off above, is a 2-stage, solid-propellant Army weapon with inertial jamproof guidance. The missile is shown below mounted on a 4-wheeled transporter-erector-launcher (TEL) which is carried by the new lightweight XM474 tracked vehicle. These, with auxiliary equipment, comprise a mobile weapon system.



ASSOCIATION AFFAIRS

Members Of Artillery Division Hear Arsenal Presentations At Frankford

An early summer meeting of the Artillery Division was held on June 17th at Frankford Arsenal, Philadelphia, Pa., and was opened by a welcoming address by the arsenal's commanding officer, Col. A. R. Cyr.

J. E. Trainer, Firestone Tire & Rubber Company, Akron, Ohio, Division chairman, introduced Maj. Gen. W. K. Ghormley, commanding general, Ordnance Special Weapons-Ammunition Command, Picatinny Arsenal, Dover, N. J. Brig. Gen. O. E. Hurlbut, commanding general, Ordnance Weapons Command, Rock Island, Ill., then presented three classified films showing firing tests and demonstrations of the spigot-type recoilless rifle, the Moritzer, and the Vigilante. He also discussed the qualitative development requirements information (QDRI) program.

R. E. Meyer, Ordnance Weapons Command, also of Rock Island, presented a summary of the supporting research being conducted for artillery improvement. He showed slides describing new concepts to offset gun recoil, improve base stability, and provide auxiliary propulsion, and also presented technical problems which had been instituted at the last annual meeting.

A presentation for Frankford Arsenal was introduced by Col. R. E. LeRoy, after which Karl Hoepfner, also of Frankford, described the fire-control development for the Vigilante. He explained how the operator functions and how he utilizes fire-control information.

G. Schecter of Frankford gave a review of two decades of progress in recoilless rifles in terms of terminal performance, weight, and probability of hit. He also discussed in detail the technical features of spigot-type recoilless rifles and the requirement for repeating recoilless rifles.

J. Pierce discussed the QDRI program as implemented by Frankford and showed charts outlining the scope and scheduling of this program.

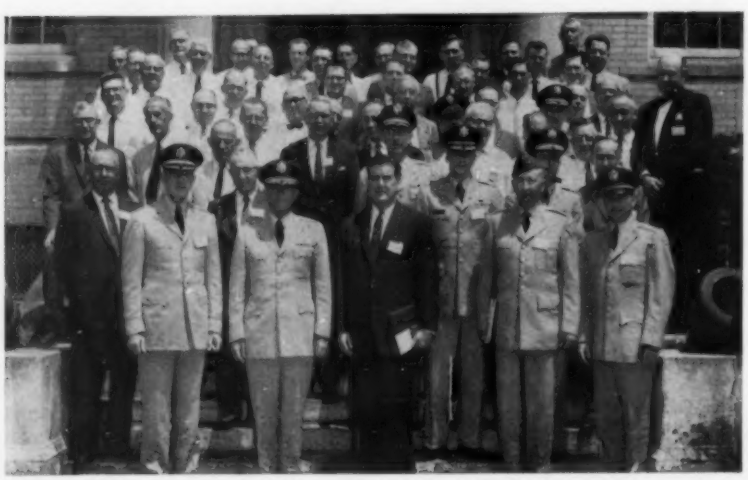
Following the morning sessions, a luncheon meeting was held at which Mr. Trainer was presented the first A.O.A. Bronze Medallion for outstanding service to the national defense.

During the afternoon, Col. W. M. Tisdale, commanding officer, Watervliet Arsenal, Watervliet, N. Y., described the new 105-mm. gun, M68, for the M60 tank and explained the new production technique for fabricating this weapon. Later, A. Muzicka of Watervliet discussed the arsenal's cannon development and showed details of the new lightweight tube and breech designs and the application of these concepts to several current development programs.

Another interesting feature of the afternoon program was a presentation by J. H. Penrose, of Watervliet Arsenal, who discussed the use of highly enlarged sections to explain the problems of finishing the forcing cone in guns to improve chromium-plate adherence and of machining buttress-type threads in breech components.

Following the regular session, an Executive Board meeting was held attended by Mr. Trainer, Col. Tisdale, Dr. J. L. Miller, S. B. Steiner, Dr. V. E. Lucas, all of Firestone; Henry Handler, Office, Chief, Army Ordnance, Washington, D. C.; Everett Baugh, Cadillac Motor Car Division, GMC, Cleveland Ordnance Plant, Cleveland, Ohio, general chairman, A.O.A. national technical Divisions and Sections; Col. Henry C. Thayer, A.O.A. staff director for public information, Washington, D. C.; A. R. Metzger, Bethlehem Steel Company, Bethlehem, Pa.; R. I. Martin, United Shoe Machinery Corporation, Beverly, Mass.; Col. R. R. Studler, also of Firestone; and Mr. Schecter.

This was the last meeting under Mr. Trainer's chairmanship, and Joseph L. Auer, R. Hoe & Company, New York, N. Y., will now assume the office.



Members of the Artillery Division of the Association attending the meeting at Frankford Arsenal, Pa. J. E. Trainer, retiring chairman, is in front row, center.

Steering Committee Of Engineering Documentation Section Meets in Washington

The Steering Committee of the Engineering Documentation Section, Production Techniques Division, met recently at the Army-Navy Club, Washington, D. C. The following members of the committee attended: W. W. Thomas, Radio Corporation of America, Moorestown, N. J., chairman; Philip Weissbrod, General Electric Company, Pittsfield, Mass., deputy chairman; Miles German, General Electric Company, Syracuse, N. Y.; Clinton A. Taylor, New Departure Division, GMC, Bristol, Conn.; E. C. Ingles, Vitro Laboratories, Silver Spring, Md.; H. H. Karpicke, Cadillac Motor Car Division,

GMC, Cleveland Ordnance Plant, Cleveland, Ohio; R. F. Franciose, General Electric Company, Schenectady, N. Y.; and John C. Duffy, General Precision, Inc., Pleasantville, N. Y.

The following recommendations were made: Mr. Weissbrod was to forward copies of "The Mission of the American Ordnance Association" to all subsection chairmen as well as information regarding logic symbols to Mr. Thomas and Mr. Franciose. It was agreed that the spring meeting of the Section would be held March 15 and 16, 1961, at New Orleans, La.

The next meeting of the steering committee will be held December 5 and 6, 1960, at New York City.

General Everest Addresses Meeting Of Volunteer Post At Nashville

At the annual meeting of the Volunteer Post in Nashville, Tenn., on April 26th, Gen. Frank F. Everest, Commander, Tactical Air Command, was guest of honor and principal speaker.

General Everest explained the mission and tasks of his command requiring instant readiness to support the Army's Ground Forces with airborne firepower and tactical troop lift. He also discussed the capabilities of TAC as an addition to the Nation's strategic retaliatory power. The general also praised the members of the American Ordnance Association for their devotion to the development and production of armament for national defense.

The presiding officer was retiring Post President F. Donald Hart of Temco, Inc., who introduced his successor, Brig. Gen. H. A. Nisley, U.S.A. (Ret.), of the Warren Paint and Color Company.

Others at the head table were: Col. Albert V. Endress, commander, 839th Air Division, Sewart Air Force Base; Brig. Gen. Frank T. McCoy, U.S.A.F.; Hon. Ben West, mayor, city of Nashville; Maj. Gen. Troup Miller, commander, Arnold Engineering Development Center, Tullahoma, Tenn.; Maj. Gen. W. C. Westmoreland, commander, 101st Airborne Division, Fort Campbell, Ky.; Maj. Gen. Howard Butler, Chief of Staff, Tennessee Air National Guard; Neil Cargile, national Council representative, Volunteer Post; and Col. William Davis, commanding officer of the Birmingham Ordnance District.

Attending Volunteer Post meeting are, left to right: Col. A. V. Endress, commander, 839th Air Division; Brig. Gen. H. A. Nisley, new president of the Post; Brig. Gen. Frank T. McCoy, U.S.A.F.; Hon. Ben West, Mayor of Nashville, Tenn.; Gen. Frank F. Everest, Commander, Tactical Air Command, the guest of honor and principal speaker; and F. Donald Hart, retiring president of the Volunteer Post.

Executive Board, Artillery Ammunition Division, Meets At Iowa Ordnance Plant

Iowa Ordnance Plant, Burlington, Iowa, was the scene of the June 2nd meeting of the Bomb, Warhead and Artillery Ammunition Division's Executive Board.

Board members present were R. L. Telford, Mason & Hanger-Silas Mason Company, New York, N. Y., chairman; James N. Pearre, also of that company; James E. Burke, Stewart-Warner Corporation, Chicago, Ill.; Dr. Herbert Ellern, Universal Match Corporation, Ferguson, Mo.; Brig. Gen. Joel G. Holmes, U.S.A. (Ret.), Mason & Hanger-Silas Mason Company; and Harvey C. Simms, Zero Manufacturing Company, Silver Spring, Md.

The problem of developing a more effective fragmentation warhead was discussed, as well as the problem of developing a low-cost method of producing high-quality continuous rod-type missile warheads with a minimum number of possible variables in manufacturing. It was felt that the method should eliminate as many of the presently used individual parts and joints as possible by incorporating new rod-forming and manufacturing techniques. Discussion also centered on developing a series of explosive delay trains to provide a variety of time delays from 0.1-second to 20 seconds with an accuracy of plus or minus 5 per cent.

General Holmes, chairman of the Loading Section, gave a report on the meeting of this Section at the Naval Ammunition Depot, Crane, Ind., in April and spoke of how the Navy had cooperated with the Section to set up the meeting. The general also cited the Fuze Section for rendering service during the Korean conflict.

Dr. Ellern, chairman of the Military Pyrotechnics Section, reported on his Section meeting held at Aberdeen Proving Ground, Md., last fall, and Chairman Simms reported on the Container Section's progress.

Mr. Telford also suggested the forming of an ad hoc committee from the Division, made up of members of various Sections for the purpose of assisting the Navy in its ammunition problems.

The chairman of the board then brought up the subject of rotation of chairmen of Divisions and Sections and asked each chairman to make a recommendation for his successor before the end of the year.

A.O.A. Posthumously Honors Col. Lawrence J. Meyns With Special Citation

A posthumous citation for outstanding service was presented recently by the American Ordnance Association to Mrs. Victoria Meyns, widow of the late Col. Lawrence J. Meyns. Colonel Meyns was cited for his part in establishing the training course in business administration for officers of the Army Ordnance Corps at Babson Institute, Babson Park, Mass.

Colonel Meyns, a native of Richmond, Va., served as an officer of the Ordnance Department of the Army from 1917 to 1947. At the time of his retirement, he was chief of the Boston Ordnance Procurement District. That year, he joined the faculty of Babson Institute of Business Administration.

Colonel Meyns was instrumental in establishing the U. S. Ordnance training program for career Ordnance officers at Babson which began in 1954. This program is an intensive 18-month course of study in business administration and in-

dustrial management presented to a carefully selected group of eight to ten Ordnance officers, usually holding the rank of captain or major.

The course is geared to the fields of management, accounting, control, procurement, and production. Other business-administration courses such as basic cost accounting, business and corporation law, and economics and managerial control, are included. Colonel Meyns was chairman of the division of production and management at Babson until his death in January 1960.

He was graduated from the Virginia Polytechnic Institute, did graduate work at Cornell University and M.I.T., and completed a course in business administration at Harvard Business School. He entered the Army in 1917 and served with distinction until his retirement. Colonel Meyns was an active A.O.A. member and was formerly president of the Yankee Post, Boston, Mass.

The Ordnance training program at Babson has been in effect for nearly seven years, and the officer graduates are working in highly responsible and sensitive military assignments throughout the world. The success of the program is due largely to the efforts of Colonel Meyns.

J. E. Trainer Receives First A.O.A. Bronze Medallion For Outstanding Service

J. E. Trainer, Firestone Tire & Rubber Company, Akron, Ohio, chairman of the A.O.A. Artillery Division, was the first recipient of the Association's Bronze Medallion, an award given for outstanding service to the national defense. Presentation was made on June 17th at a luncheon at Frankford Arsenal, Philadelphia, Pa., by Col. Henry N. Marsh, former Assistant Secretary of the Army for Logistics and now vice-president in charge of A.O.A. technical Divisions.

J. E. Trainer, Artillery Division chairman, left, receives Bronze Medallion from A.O.A. Vice-President Henry N. Marsh.

Maj. Gen. E. P. Mechling, U.S.A.F. (Ret.), staff director for technical operations, A.O.A., read the following citation which accompanied the medallion:

"Ardent patriot, acknowledged production expert, and respected industrial leader, Mr. Trainer has devoted his skill, as well as the capabilities of the Firestone Tire & Rubber Company, to the security of the United States. He has for decades given his steadfast guidance, wise counsel, and broad vision to all the major activities of the American Ordnance Association for the advancement of adequate national defense in the fields of weapon technology, production, and logistics.

"Mr. Trainer is a member of the Association's Advisory Board and served as a member of the Board of Directors from 1948 to 1960. He organized the Artillery Division in 1945 and remained its chairman for fifteen years. He becomes chairman emeritus on July 1, 1960, and is vice-president and a director of the Association's Cleveland Post. This award bespeaks admiration and gratitude of all officers and members of the Association. With it are conveyed their sincere wishes for his health, happiness, and continued success in the years to come."

Mr. Trainer joined Firestone in 1938 and directed the company's extensive defense activity in World War II and the Korean conflict and served on the War Production Board during 1945-1946.

Combat Vehicle Division Presents Donation To Fort Benning Charitable Fund

Another example of the A.O.A. role in promoting peace and understanding in a restless world is its charitable activity. Benevolence, Association members feel, is important in a Communist-infiltrated universe where the word "charity" is seldom heard.

Typical of this was the donation of $672.73, the proceeds of the Combat and Tactical Vehicle Division's spring meeting at Fort Benning, Ga., to St. Michael's Discretionary Fund of that base.

Maj. Gen. Hugh P. Harris, U.S.A., commanding general of Fort Benning, recently wrote a letter to J. M. Heyne, Cleveland Ordnance Plant, General Motors Corporation, Cleveland, Ohio, who was meeting cochairman, thanking Division members.

Citadel Post Members Go Aboard Submarine Tender At Charleston Naval Base

Twenty-eight members of The Citadel Post were guests aboard the HOWARD W. GILMORE, a submarine tender at the Charleston Naval Base.

Upon boarding the ship the cadets split into small groups, each escorted by a crewman who showed and explained to the cadets the maze of shops, laboratories, storage rooms, and gun batteries which made up the large vessel. The cadets were shown how a ship of this type services, repairs, and supplies the submarines and other units attached to its submarine squadron.

The cadets ate dinner on the ship before returning to the campus. Accompanying the group was Capt. R. E. Round, assistant professor of military science and tactics at The Citadel.

Ad Hoc Committee On Value Engineering Becomes Special Committee After Panel Study

The ad hoc committee on value engineering became a special committee on May 18th, following the completion of a study and discussion of the needs for such a committee by A.O.A. representatives and Navy consultants.

W. M. Gourley, Philco Corporation, Philadelphia, Pa., chairman of this special committee, was in charge of the meeting held at the Main Navy Building, Washington, D. C., when the decision for the transition was made. The chairman described the status of the new committee and said that nominations of new members had been received from the various A.O.A. Divisions. The committee will go into operation as soon as a full quota of membership is received.

Loading Section Members Hear Admiral Hirsch And Panelists At Annual Meeting

The annual meeting of the Loading Section, Bomb, Warhead and Artillery Ammunition Division, was held at the U. S. Naval Ammunition Depot, Crane, Ind., in late spring with Brig. Gen. Joel G. Holmes, U.S.A. (Ret.), of Mason & Hanger-Silas Mason Company, Section chairman, presiding.

General Holmes thanked Capt. Leonard J. Baird, commanding officer at NAD, and his staff for the fine arrangements made for the meeting. Captain Baird also

addressed the A.O.A. members saying, "Meetings such as this are indicative of the cooperative spirit that exists between industry and the armed services. They help, through exchange of ideas, to improve our weapons and thereby the security of our country."

Maj. Gen. William K. Ghormley, commanding general, Special Weapons-Ammunition Command, Dover, N. J., was introduced next and praised the A.O.A. technical meetings. He told members that in addition to providing the privilege and opportunity of discussing technical problems, these occasions offer a chance of meeting people and exchanging ideas.

Comdr. Bruce P. Piersall, assistant commanding officer for the ammunition program of the Bureau of Naval Weapons at NAD, added his welcome to that of Captain Baird. Col. Henry C. Thayer, director of public information, A.O.A. headquarters, then addressed the group, congratulating the section on being a part of the oldest A.O.A. technical Division.

Division Chairman R. L. Telford, Mason & Hanger-Silas Mason Company, New York, N. Y., expressed his interest in the Loading Section and pointed out the areas of contributions made by the Association.

Highlight of the dinner meeting was the address of guest speaker, Rear Adm. M. A. Hirsch, Assistant Chief for Fleet Readiness, Bureau of Naval Weapons, Washington, D. C., whose topic was "How the Bureau of Naval Weapons has been organized to serve the needs of the fleet."

A large number of papers were presented dealing with various subjects of interest to Loading Section members. These were given by: H. M. Krengel, Ravenna Arsenal, Ravenna, Ohio; Col. L. C. Sorensen, Ordnance Ammunition Command, Joliet, Ill.; Thomas L. Gaines, Louisiana Ordnance Plant, Shreveport, La.; D. E. Heffelbower, Mason & Hanger-Silas Mason Company, Burlington, Iowa; Paul B. Tweed, Feltman Research and Engineering Laboratory, Picatinny Arsenal, Dover, N. J.; L. Colleti, Picatinny Arsenal; Frederick M. Bishoff, Office, Chief of Army Ordnance, Washington, D. C.; J. A. Taylor, Picatinny Arsenal.

Also, C. W. Falterman, U. S. Naval Ordnance Test Station, China Lake, Calif.; William McBride, Naval Weapons Station, Yorktown, Va.; Dr. Walter C. McCrone, McCrone Associates, Chicago, Ill.; Robert J. Shirock, Ordnance Field Safety Office, Jeffersonville, Ind.; Arthur C. Forsyth, Feltman Research and Engineering Laboratory, Picatinny Arsenal; Norman E. Beach, also of Picatinny Arsenal; G. H. Yocum, Ravenna Arsenal; O. B. Hunt, Joliet Arsenal, Joliet, Ill.; Richard M. Rindner, Picatinny Arsenal; Milton Roth, also of Picatinny; and M. H. Wegener, Mason & Hanger-Silas Mason Company, Burlington, Iowa.

Powder Metallurgy Section Inspects Five Plants During Visitation Program

The Powder Metallurgy Section of the Materials Division held a plant visitation at Detroit, Mich., late in the spring, as part of its program of technical education and cooperation with Ordnance arsenal personnel. During the 2-day visitation, five plants were visited, covering practically every facet of commercial production by powder metallurgy. Manufacture of porous bearings, friction materials, and many other specialized products was exhaustively studied by ordnance engineers and carefully explained by the host companies.

During the evening sessions ample time was afforded for discussion between Government personnel and representatives of the host companies to review the past effort of the Powder Metallurgy Section to acquaint design and production engineers with the capabilities of the powder metallurgy process. It was felt that other technical Sections of A.O.A. might profitably arrange similar visitation programs.

Section Chairman A. J. Langhammer said that the Section intends to hold further plant visitation meetings in the future. He praised the efforts of Ordnance personnel to learn and benefit by these visits and pointed to a number of examples of current production of complicated powder-metallurgy parts which probably would not have been adapted to this process successfully without the background knowledge and experience imparted by such efforts.

Some of the members of the Association's Powder Metallurgy Section, Materials Division, during the 2-day visitation of five plants in the Detroit area.

Planning And Programming Committee Formed To Improve Technical Operations

A Planning and Programming Committee to study approaches for the improvement of A.O.A. technical operations was formed in May and held its first meeting in June at Washington, D. C.

Everett L. Baugh, Cadillac Motor Car Division, GMC, Cleveland Ordnance Plant, Cleveland, Ohio, general chairman of Technical Divisions and Sections, was appointed chairman of the new committee. Maj. Gen. Edward P. Mechling, A.O.A. staff director for technical operations, was named deputy chairman, and Col. Henry C. Thayer, staff director for public information, was made secretary. Col. Henry N. Marsh, Wilmington, Del., association vice-president, also attended the first meeting in Washington on June 7th and 8th.

In most instances, Division chairmen have appointed members of their Divisions to represent them on the committee. These representatives are: Dr. Philip H. Burdett, Remington Arms Company, Bridgeport, Conn., Small Arms and Small Arms Ammunition Division; Col. William J. Darmody, U.S.A. (Ret.), Sheffield Corporation, Dayton, Ohio, Standards and Metrology Division; Walter E. Faithorn, Jr., Stewart-Warner Corporation, Washington, D. C., Bomb, Warhead and Artillery Ammunition Division; Harry L. Ingram, Jr., Air Reduction Company, Washington, D. C., Combat and Tactical Vehicle Division; Christy H. Madsen, Naugatuck Chemical Division, U. S. Rubber Company, New York, N. Y., Materials Division; A. Richard Metzger, Bethlehem

Adm. A. G. Noble, chairman emeritus of the Association's Underwater Division, left, presents the A.O.A. Adm. W. H. P. Blandy Memorial Award, an engraved shotgun, to Midshipman Glenn L. Barton at the Naval Academy, Annapolis, Md.

A.O.A. Vice-President Henry T. Luria, left, presents the A.O.A. Col. James L. Walsh Memorial Award, a sporting rifle, to Cadet James J. Stewart at the U. S. Military Academy for proficiency in ordnance. These awards are made annually.

Steel Company, Bethlehem, Pa., Artillery Division.

Division chairmen representing their respective Divisions are: Dr. G. R. Tatum, Vitro Laboratories, Silver Spring, Md., Underwater Ordnance Division; and Thomas P. Wharton, Packaging Consultants, Inc., Washington, D. C., Packaging and Handling Division.

Committee members reviewed certain problems and made plans for future operations. The interest of the A.O.A. in human engineering also was discussed and plans were made to send a list of specialists in this field to the commodity Divisions. Commodity Division chairmen will make the distribution of the lists which will include the names of specialists from both Government and private industry. It was decided that no special organization on human engineering will be established at the present time.

Since the subjects of reliability, quality control, and qualification testing are of broad and continuing interest to the technical Divisions, the Planning and Programming Committee will monitor this interest and coordinate necessary mutual support between Divisions. It was announced that a report from the Committee on Value Engineering would be presented at the next meeting.

Interest of the A.O.A. in technical publications of the armed forces also was discussed, particularly in the field of maintenance and supply, and an ad hoc committee was appointed by Mr. Baugh to prepare recommendations for further action in this field. Members of the ad hoc committee are Dr. Tatum, chairman, Mr. Burdett, and Mr. Kadie.

All members participated in a discussion on arrangements for mutual support between Divisions and Sections, and several areas of mutual interest were determined.

The problem of funding technical meetings and A.O.A. technical operations was explored. The particular problem was the cost of preparing full reports on Section meetings, and it was determined that the cost of publishing such reports must be included in the meeting fee. Standard arrangements for handling meeting fees and clearances through A.O.A. headquarters, as indicated in the Manual, are to be followed.

Eugene G. Grace For Many Years Was An Active Member Of The Ordnance Association

Eugene Gifford Grace, a member of the American Ordnance Association and former president and honorary chairman of the Bethlehem Steel Corporation, died at Bethlehem, Pa., on July 25, 1960. A leader in the steel industry, Mr. Grace was also an active supporter of the Association since its beginning.

Mr. Grace was a graduate of Lehigh University. His first employment was at Bethlehem Steel Company's small plant in Bethlehem as an electric crane operator. During the fifty years following, he rose to direct one of the world's largest steel producers.

During the First World War he led the organization of the steel industry's development as a major factor in the war effort. And again in World War II he repeated this accomplishment. He had a leading part in the inauguration and operation of the Controlled Materials Plan which was intended to assure steel for military and civilian needs.

Under Mr. Grace's supervision, the Bethlehem Steel Company became a leading developer and producer both of armor plate and of armor-piercing projectiles. He also guided the company in the production of ships. He was closely identified with many of the leading figures in the ordnance effort during the past fifty years and was a strong support in the formation of the Ordnance Association in 1919.

Gun Tube Section Discusses High-Strength Materials At Philadelphia Meeting

High-strength materials for gun tubes and component parts was the principal topic at a spring meeting of the Gun Tube Section, Artillery Division, held at Frankford Arsenal, Philadelphia, Pa.

Section Chairman A. R. Metzger, Bethlehem Steel Company, Bethlehem, Pa., conducted the meeting of the newly organized Section. John Penrose, a Section consultant, Watervliet Arsenal, N. Y., presented new Ordnance concepts pertaining to gun tubes, breech rings, and muzzle brakes.

Although the discussion touched upon cold-work methods and erosion-resistant materials, primary emphasis was placed upon the need for steel with appreciably high minimum yield strengths.

A.O.A. Honors Outstanding R.O.T.C. Cadets With Scholarship Key Awards

Each year the honor Ordnance cadets in the R.O.T.C. units in colleges throughout the country are awarded the American Ordnance Association Scholarship Key. The awards were made recently to the students named below at the following institutions:

University of Arkansas.—Cadet Lieut. Col. Jon R. Morgan, Piggott, Ark., was a distinguished military student. He was the R.O.T.C. brigade executive officer and was the outstanding cadet in his company at the 1959 R.O.T.C. Summer Camp at Fort Hood, Tex. He has applied for a Regular Army commission.

University of California.—Cadet Col. Leonard John Loomis, Salt Lake City, Utah, is a distinguished military student. He majored in business administration and is a member of the Phi Sigma Kappa fraternity and also belonged to the University of California Men's Glee Club. Upon graduation, Cadet Loomis is accepting a Regular Army commission in the Ordnance Corps.

Association Affairs

University of Cincinnati.—Cadet Jack E. Lower is a distinguished military student majoring in electrical engineering. He is president of Omicron Delta Kappa, vice-president of Phi Delta Theta, and a member of various organizations such as Scabbard & Blade, Pershing Rifles, and Student Council.

Cornell University.—Cadet Edward J. Savitsky, Mary-D, Pa., majored in electrical engineering. He was a distinguished military student, a member of Scabbard & Blade, and was voted the "most valuable player" award for participation on the varsity football team. He will be commissioned as a second lieutenant in the Ordnance Corps.

The Citadel.—Cadet 2nd Lieut. James C. Fields, Atlanta, Ga., has been designated a distinguished military student. Cadet Fields has been active in the American Ordnance Association, the Society of American Military Engineers, the Knox Chemical Society, and the Association of the U. S. Army. He has been on the Dean's List for four semesters.

Clemson Agricultural College.—Cadet Col. James Carlisle Scott, Jr., Gaffney, S. C., majored in industrial management. He is a member of Scabbard & Blade Sigma Tau Epsilon, Pershing Rifles, and is listed in Who's Who in American Colleges and Universities.

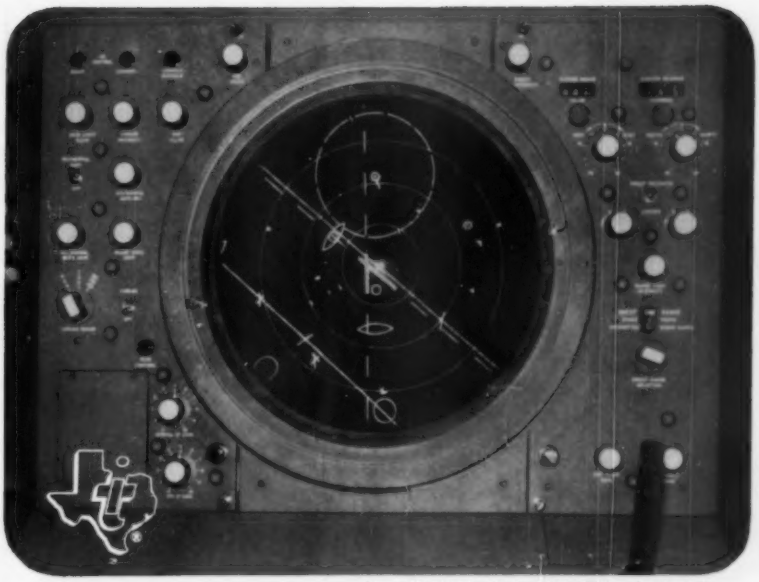
Dartmouth College.—Cadet Jeffrey Ira Fine, New York, N. Y., majored in business administration. He participated as a member of the varsity swimming team and was a member of the Dartmouth Outing Club.

University of Dayton.—Cadet Thomas A. Bell, East Cleveland, Ohio, is a distinguished military student. He majored in mechanical engineering while at the University of Dayton and will apply for a Regular Army commission in the Ordnance Corps.

Georgia Institute of Technology.—Cadet Capt. Wallace B. Bruce, Jr., Gainesville, Ga., is a distinguished military student majoring in industrial engineering. He is president of Beta Theta Pi Fraternity, a member of Alpha Pi Mu, Tau Beta Pi, and Scabbard & Blade. He was awarded a year's scholarship to study in Germany after which he is interested in a Regular Army commission.

University of Illinois.—Cadet Capt. Urban A. Weidner, Urbana, Ill., has been designated as a distinguished military student, and majored in marketing. He was a member of the "I" Men's Association and Sigma Nu Fraternity. He will be commissioned in the Ordnance Corps.

University of Kansas.—Cadet Capt. Lawrence L. Dieker, Salina, Kans., enrolled in the School of Business, was a distinguished military student. He was the supply officer of the University of Kansas Company of Pershing Rifles, national



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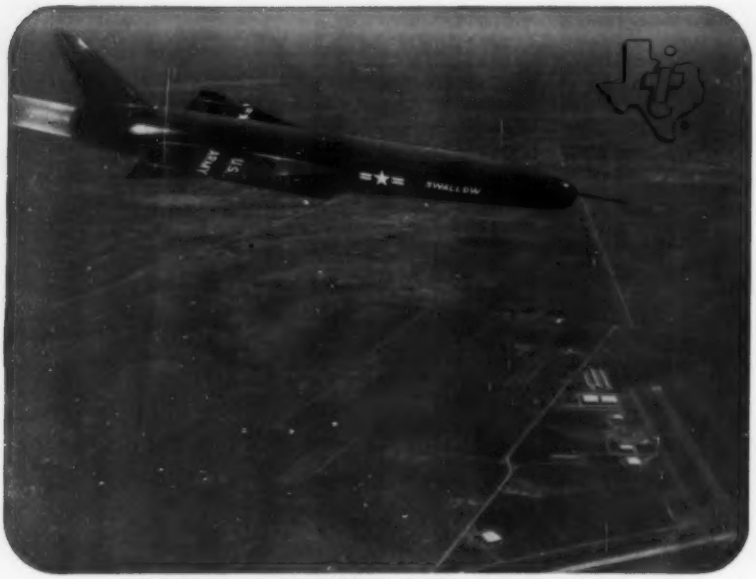

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Association Affairs (Contd.)

honorary military fraternity; a member of the University of Kansas Association of the United States Army Company; president of his social fraternity, Phi Kappa Theta, and treasurer of the All Student Council. He will be commissioned in the Ordnance Corps.

Knox College.—Cadet Lieut. Col. Edward Andrew Vondrak, Chicago, Ill., majored in physics. He was a distinguished military student and a member of Phi Beta Kappa and Scabbard & Blade. Upon graduation he will be commissioned in the Ordnance Corps.

Lafayette College.—Cadet Joseph M. Barletta, New York City, N. Y., was majoring in electrical engineering. He participated in sports, particularly the varsity track team, the A.I.E.E. and I.R.E., Scabbard & Blade, and was captain of the Pershing Rifle Company.

Lehigh University.—Cadet Robert N. Smiley, Slippery Rock, Pa., majored in chemical engineering. He displayed outstanding ability, resourcefulness, and all-around excellence in the R.O.T.C. program. He was a member of Beta Theta Pi Fraternity, and was a member of the Scabbard & Blade Society.

Louisiana State University.—Cadet Robert R. Blanchard, Port Allen, La., is a distinguished military student. He majored in chemistry and physics and was a member of Alpha Chi Sigma (chemistry), Sigma Pi Sigma (honorary physics), Scabbard & Blade (military), American Chemical Society, and the Society of American Military Engineers. Upon graduation he will be commissioned as a second lieutenant in the Ordnance Corps.

University of Maine.—Cadet Capt. Max William Stewich, Lisbon Falls, Maine, majored in engineering physics and was student director of the university band and cadet captain of the R.O.T.C. band. He will be commissioned a second lieutenant in the Ordnance Corps.

Massachusetts Institute of Technology.—Cadet Col. Robert S. Troth, Oakton, Va., majored in electrical engineering. He has been active in both Scabbard & Blade and Pershing Rifles. He was a member of intervarsity Christian Fellowship and the Wesley Foundation, and excelled in a number of intramural sports.

Michigan State University.—Cadet Capt. Douglas B. Ostien, Philadelphia, Pa., majored in mathematics and physics. He has been designated a distinguished military student. His campus and community activities included participation in the Pi Mu Epsilon fraternity, Spartan Christian Fellowship, and was director of the Baptist Church choir.

University of Minnesota.—Cadet Maj. Robert D. Peterson, Minneapolis, Minn., has been designated as a distinguished military student. He majored in accounting in the School of Business Administra-

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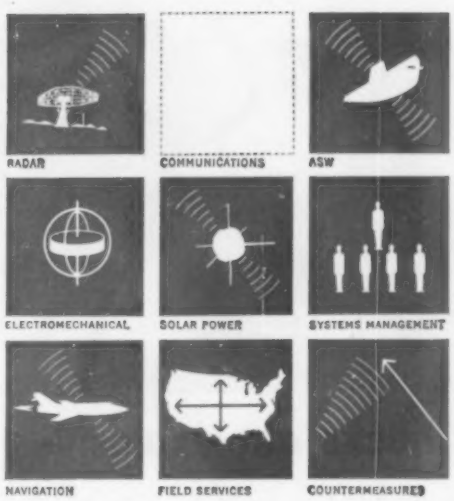

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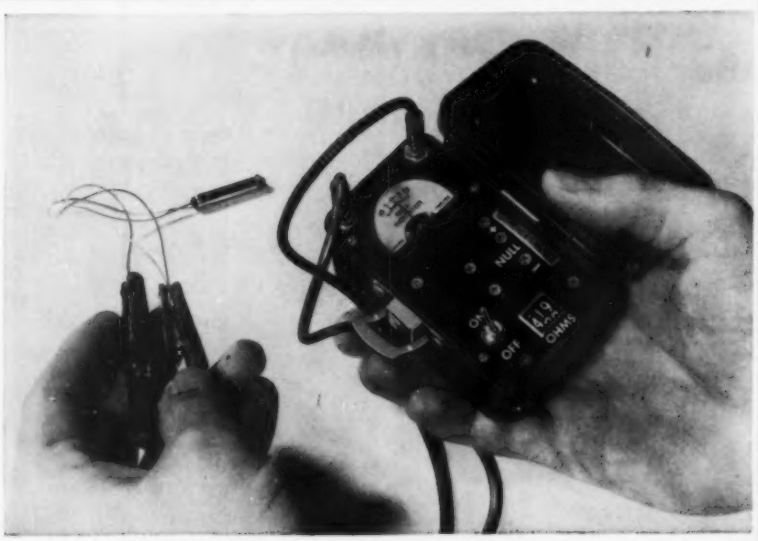

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tion. He has been an active member of the Army R.O.T.C. Rifle Team, Scabbard & Blade, and the University Accounting Club. He will be commissioned in the Ordnance Corps.

Missouri School of Mines and Metallurgy.—Cadet Lieut. Col. Louis C. Rephlo, Jefferson City, Mo., majored in electrical engineering. He was vice-president of Blue Key; a member of Pi Kappa Theta, Eta Kappa Nu, Tau Beta Pi, and

J. R. Morgan

L. J. Loomis

Phi Kappa Phi. He will be commissioned as a second lieutenant in the Ordnance Corps.

Murray State College.—Cadet William R. Threlkeld, Lakeland, Ky., majored in mathematics. He will be commissioned a second lieutenant in the Ordnance Corps.

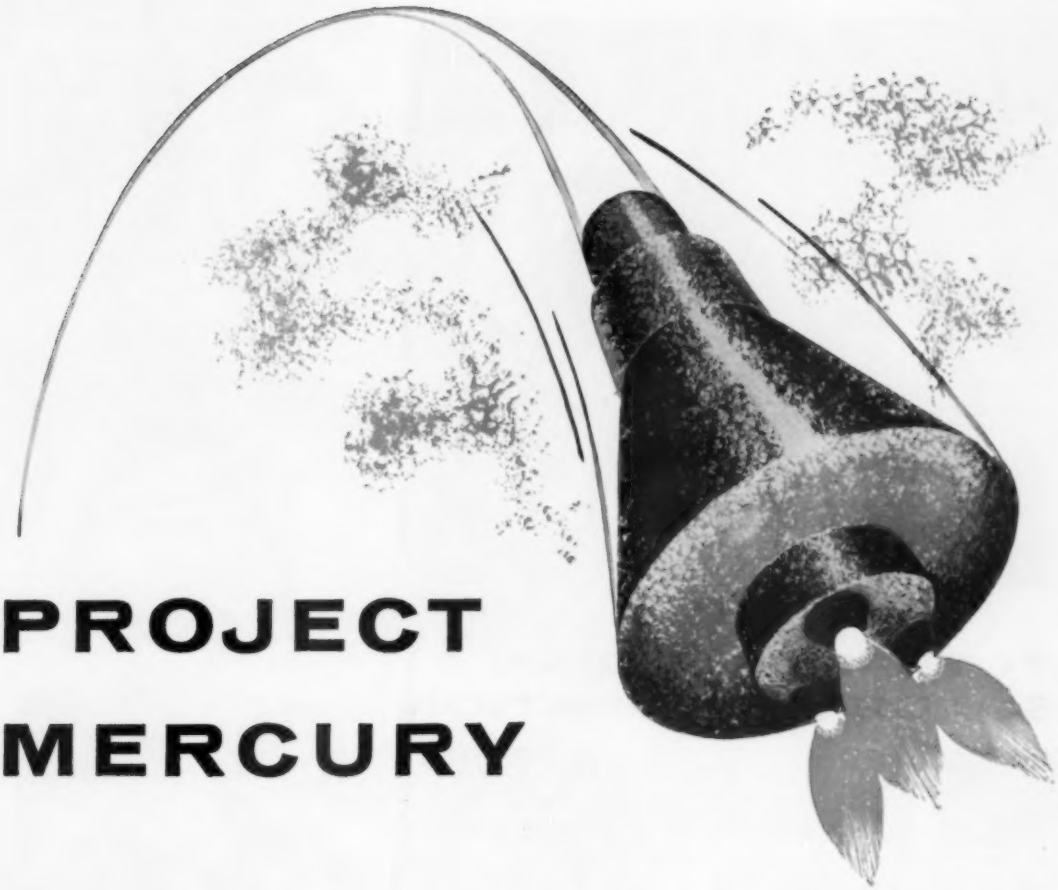
University of New Hampshire.—Cadet Herbert N. Clark, Portland, Maine, was designated a distinguished military student. His major area of study was government. Cadet Clark was a member of the varsity rifle team, is a member of the Scabbard & Blade Military Society, and also a member of the Sigma Alpha Epsilon social fraternity. He will be commissioned a second lieutenant in the Ordnance Corps and plans to accept a Regular Army commission.

North Dakota Agricultural College.—Cadet Frederick D. Williamson, a chemical technology major, was designated a distinguished military student because of his academic, military, and leadership abilities. He served actively as treasurer of Dakota Company, Association of the

E. J. Savitsky

J. J. Fine

U. S. Army, has been active in the Chemistry Club, and during the fall quarter served as battle group commander. Upon his graduation he will be commissioned in the Ordnance Corps. (*Contd. on p. 230*)



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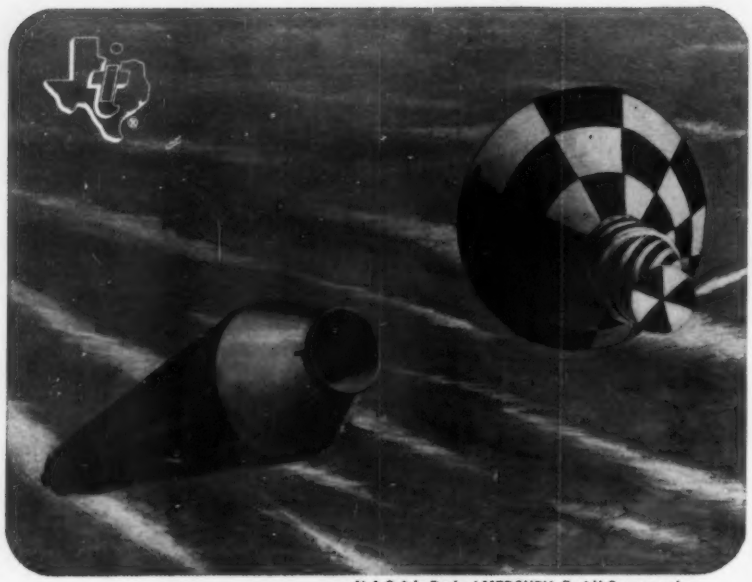

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Association Affairs (Contd.)

J. C. Fields

Carlisle Scott, Jr.

University of Notre Dame.—Cadet George M. Richvalsky, Bayonne, N. J., majoring in electrical engineering, has been selected as a distinguished military student. At Notre Dame he has been on the dean's list, secretary of the A.I.E.E., a member of the Metropolitan Club, and has been selected for assignment to the Ordnance Corps.

Ohio State University.—Cadet Maj. John S. Fletcher has been designated as a distinguished military student. He is a member of the Pershing Rifles, Scabbard & Blade, and a member of the varsity wrestling team.

T. A. Bell

W. B. Bruce, Jr.

Oklahoma State University.—Cadet Col. Fred M. Welsh has been designated as a distinguished military student. He majored in engineering and will be commissioned in the Ordnance Corps.

Pennsylvania Military College.—Cadet Capt. James W. Brown, St. Louis, Mo., was designated a distinguished military student. He was an honor member of the Triangle Club, honorary engineering society, and also a member of Theta Chi fraternity, Engineers' Club, Society of American Military Engineers, and the wrestling team. While a member of the Pershing Rifles he was a participant when the team won over thirty-five trophies in

L. L. Dieker

U. A. Weidner

Northwestern is the only commercial source in the world that manufactures and supplies service parts for all type models of U. S. made tactical and combat military vehicles. Here is why more than 40 nations purchased the majority of these needs from Northwestern last year.

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2 Northwestern knows military vehicles, and in 41 years of business has supplied virtually every part needed to keep them running.

3 Northwestern delivers guaranteed parts . . . always in accordance with the original manufacturer's specifications and quality. Napco's combined manufacturing facilities encompass over 800 major machine tools and 1200 employees.

Quotations on requirements parts lists are invited Master Parts Catalog is available free to interested representatives, governments and military personnel.

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Somewhere in a wasteland, the Air Force Minuteman will keep its lonely vigil all through a thousand nights. Buried and untended, it must be ready to spring to life if the button is ever pushed.

Minuteman poses a real challenge to the New Reliability—reliability which must guarantee successful firing at any moment in the far future. Each of the missile's systems, each of its thousands of electronic components, must function perfectly at that given moment. For once the missile is lowered into its silo, no human hands again need touch it.

The Minuteman's critical guidance and control system has been entrusted to Autonetics. We are proud to be a member of this United States Air Force missile team.

Once again America's defense force reaps the harvest of Autonetics' pioneering. A decade of experience with major projects has given Autonetics a unique capability in systems management—and in meshing its work with that of other companies in building modern weapon systems.

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R. N. Smiley

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three years. He plans to enter Rensselaer Polytechnic Institute on an assistantship awarded to him by that institution to earn his doctor's degree in physics. After graduate study he will enter the Ordnance Corps as a second lieutenant.

Pennsylvania State University.—Cadet Maj. David A. Nelson, Erie, Pa., majored in engineering. He was president of Sigma Tau Gamma, a member of American Society of Mechanical Engineers, and will be commissioned in the Ordnance Corps upon graduation.

Polytechnic Institute of Brooklyn.—Cadet Noel X. DeLessio, New York, N. Y., majored in electrical engineering and expects to continue his studies in this field.

Rutgers University.—Cadet Maj. Robert C. Brinster, Jr., Pompton Lakes, N. J., majored in agriculture. He was commander of the combined Army and Air Force Band, a member of Scabbard & Blade, and secretary of the Kappa Kappa Psi honorary band fraternity. He will be commissioned as a second lieutenant in the Ordnance Corps.

DISCERNING DRAFTSMEN THE WORLD OVER DEMAND IMPERIAL THE WORLD'S FINEST TRACING CLOTH

M. W. Stewich

R. S. Troth

Sam Houston State Teachers College.—Cadet Terry M. Carlton, Groveton, Tex., majored in physics. He was designated as a distinguished military student and president of Delta Tau Delta fraternity. He has been selected for Who's Who in American Colleges and Universities. He will enter the Regular Army with a commission in the Ordnance Corps.

Spring Hill College.—Cadet Maj. Faustin N. Weber, Memphis, Tenn., majoring in physics, is a member of the Scabbard & Blade; an officer of Omicron Sigma fraternity, and a member of Spring Hill College Physics Club. Upon graduation he will receive a commission as a second lieutenant in the Ordnance Corps.

Stanford University.—Cadet Capt. Kirk Beales, San Francisco, Calif., majored in chemical engineering. Cadet Beales was a most outstanding student having achieved the highest on the U. S. Army Rq-4 test ever attained by a student. He was an active member of the Stanford rifle team, Scabbard & Blade, Association of the United States Army, and American Institute of Chemical Engineers. He was appointed a distinguished military student. He has been offered a research assistantship in chemical engineering at Berkeley after serving on active military duty.

State University of South Dakota.—Cadet Lieut. Col. David William Eyres, Baltimore, Md., has been designated as a distinguished military student. He has been majoring in applied science and stood first in a graduating class of nineteen. He held offices in various fraternities including Phi Eta Sigma and Phi Mu Alpha. He was vice-president of Scabbard & Blade and was mentioned in Who's Who Among Students in American Universities and Colleges. He participated in intramural sports, particularly basketball

R. D. Peterson

L. C. Rephlo

W. R. Threlkeld

H. N. Clark

D. B. Ostien

G. M. Richvalsky

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Association Affairs (Contd.)

and bowling. Cadet Eyres has received the Walter P. Murphy fellowship for graduate study in engineering at Northwestern University's Technological Institute.

St. John's University.—Cadet Col. John R. Ficenec, Rochester, Minn., was nominated and has accepted a fellowship at Iowa State University, Ames, Iowa, in nuclear science. Colonel Ficenec tied for first place in his senior class of 213, receiving a grade of A in all semesters. He participated actively in athletics

J. S. Fletcher

J. W. Brown

D. A. Nelson

and was a member of the Monogram Club. He was selected for assignment to the Ordnance Corps upon being commissioned last June.

Syracuse University.—Cadet Lieut. Col. Joseph Mercurio, Syracuse, N. Y., majoring in mathematical education, was president of Pi Mu Epsilon math fraternity, president of Kappa Sigma fraternity, a member of the senior executive council, and has been on the dean's list for several years. He is a distinguished military student.

University of Tennessee.—Cadet Maj. John D. Broyles, Maryville, Tenn., was designated as a distinguished military student. He majored in industrial engineering. He is a member of the American Institute of Industrial Engineers and Scabbard & Blade.

Texas Technological College.—Cadet Capt. Donald L. Zimmerman, Oklahoma City, Okla., now working toward a dual degree in speech and mathematics, is a distinguished military student. He is a member of the Sigma Chi fraternity and Scabbard & Blade. He was vice-president of the Tech Speech Association and Tech Toastmasters. Cadet Zimmerman hopes eventually to enter Harvard Law School. He will accept a commission in the Ordnance Corps.

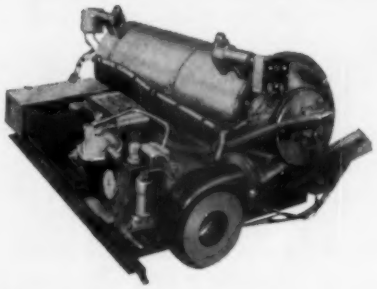
Texas Western College.—Cadet Lieut. Col. William S. Creighton, Jr., El Paso, Tex., majored in business administration. He has been designated as a distinguished military student and is a member of Delta Sigma Pi, Sigma Chi, and Scabbard & Blade. He is in Who's Who in American Colleges and Universities and was on the dean's list. He was one of the two most outstanding senior R.O.T.C. cadets and has been tendered a Regular Army commission in the Ordnance Corps.

Vanderbilt University.—Cadet Capt. Ted L. Lee, Nashville, Tenn., majoring in mechanical engineering, was a member of Pershing Rifles, assistant PIO on the cadet battle group staff, and is a member of Scabbard & Blade. Cadet Lee is a member of the Student Christian Association, Junior Athletic Association, and Tau Beta Pi honorary engineering fraternity.

R. C. Brinster

N. X. DeLessio

W. S. Creighton, Jr.



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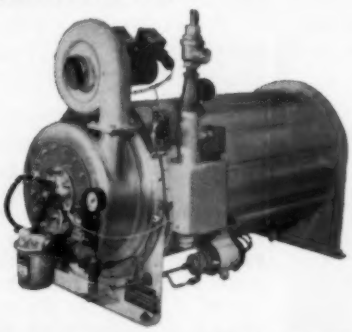
for support vehicle comfort and cargo heating, windshield defrosting. Ideal for use on fire trucks, movers, weapons loaders, personnel carriers, in temperatures to −65°F.



500,000 Btu/hr Janitrol liquid heater

for structures, large vehicles, and for heating decontaminants and cleaning fluids on mobile ice removal units.

1,000,000 Btu/hr Janitrol liquid heater

for heating chemicals during storage and transfer, vaporizing liquids, and in a wide variety of support vehicles and buildings. Approximately 18″ in diameter, 47″ high, weight: 270 lbs.

liquid heater packages for reliable ground support

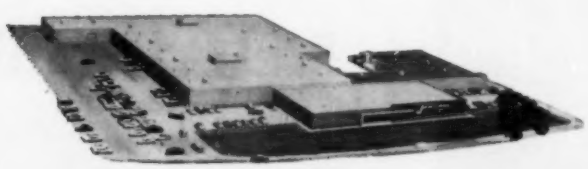
Missile and aircraft support equipment builders use Janitrol liquid heater packages—for comfort and cargo heating, structures, special vehicles, or wherever the convenience of liquid heat can be utilized—because they're built for and have been proved in scores of military applications.

They meet appropriate MIL specifications, are fully qualified, and are supplied in outputs up to one million Btu/hour. They provide any desired amount of heat up to rated output and automatically maintain constant temperatures.

As an example of acceptance, most Air Force crash-fire vehicles are equipped with one or more of these heaters, for engine, chemicals, cargo and crew space heating. Multi-fuel operation is standard, and they perform reliably in multiples for heat requirements which exceed the output of a single unit.

Write for detailed specifications proposals to the Liquid Heater Department, Janitrol Aircraft, a division of Midland-Ross Corporation, Columbus 4, Ohio.

pneumatic controls • duct couplings and supports • heat exchangers • combustion equipment for aircraft, missiles, ground support



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Write for "Janitrol Resources," brochure on Janitrol capabilities.

T. M. Carlton

F. N. Weber

Kirk Beales

D. W. Eyres

J. D. Broyles

Joseph Mercurio

University of Virginia.—Cadet Maj. Eugene E. Leasure, Jr., Petersburg, Va., majoring in electrical engineering, was designated a distinguished military student. He was president of Eta Kappa Nu, national electrical engineering honor society. He was a member of Jefferson Sabres, Theta Tau national professional engineering society, and demonstrated outstanding military leadership.

Virginia Polytechnic Institute.—Cadet Sgt. Stanley M. Wolf, Baltimore, Md., was a distinguished military student. He was a member of the Phi Kappa Phi and Alpha Sigma Mu fraternities and is listed in "Who's Who in American Colleges and Universities."

University of Washington.—Cadet Argie E. Haddock, Aledo, Tex., was a distinguished military student majoring in electrical engineering. Cadet Haddock was a member of Scabbard & Blade and the student chapter of the Association of the U. S. Army.

Western Michigan University.—Cadet 1st Lieut. Lamar E. Bullock, Hastings, Mich., majoring in physics, is expected to graduate with physics honors and a National Science Foundation undergraduate research grant. He participated on the rifle team, physics seminar, and was associated with the American Association of Physics Teachers. Cadet Bullock showed great potential for leadership and has been assigned to the Ordnance Corps.

T. L. Lee

A. E. Haddock

West Virginia University.—Cadet Lieut. Col. John P. Scherlacher, Pittsburgh, Pa., majored in electrical engineering. Cadet Scherlacher is a distinguished military student and is secretary of the Sigma Chi social fraternity. He is a member of the American Institute of Electrical Engineers, Scabbard & Blade, Phi Beta Pi, and Theta Kappa Nu. He was recipient of the R.O.T.C. gold medal award of the Society of American Military Engineers.

We Believe that Peaceful co-existence is best maintained by being Too Tough to Tackle

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Announcing a new line of Caterpillar four-cycle Diesels that sharply reduce physical dimensions and weight-to-horsepower ratio. Features of durability, fuel economy and dependability, long associated with Cat four-cycle Diesels, are retained.

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For complete performance specifications on these new Caterpillar Diesels or on the complete line, see your Caterpillar Dealer. Or, write to Engine Division, Caterpillar Tractor Co., Peoria, Illinois, U. S. A. Ask for the catalog on the complete Caterpillar Engine line.

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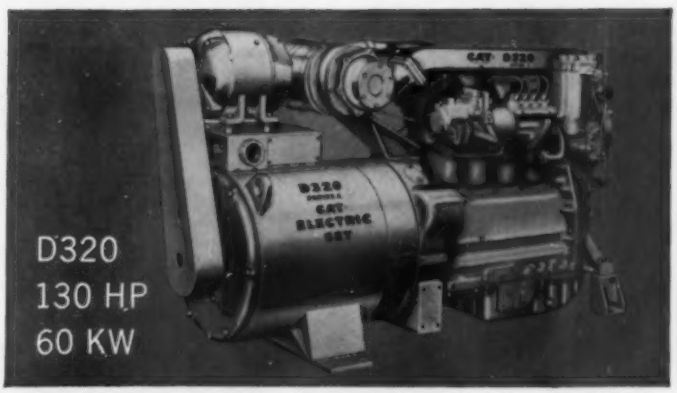

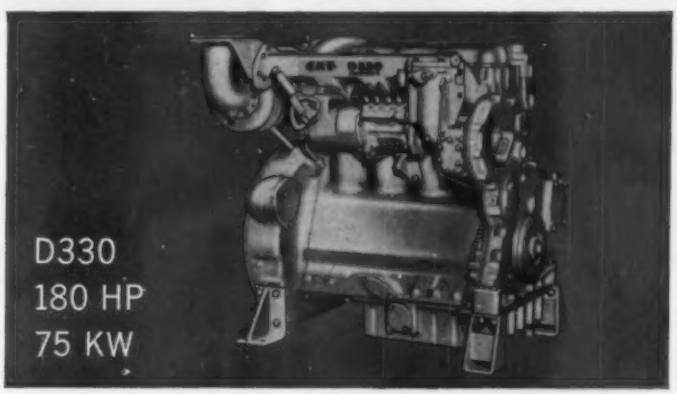

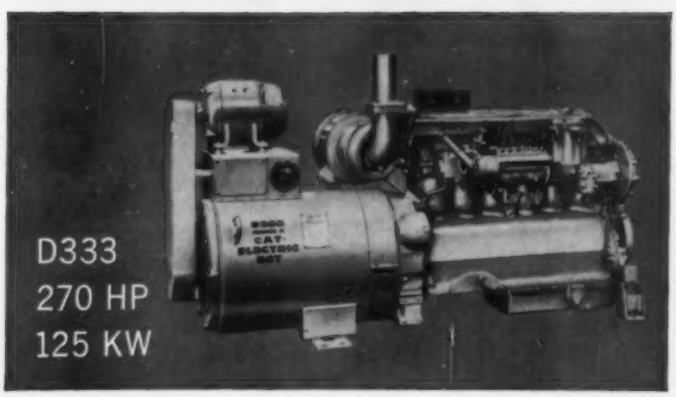

NEW DEVELOPMENTS

Pershing System Tested

The Army recently fired its Pershing ballistic missile successfully from its self-contained transporter-erector-launcher (TEL) mounted on a tracked vehicle. The entire Pershing system is transported on these tracked vehicles which will give the weapon true battlefield mobility (see photo on page 219).

The firing was a threefold success, proving out the transporter and the launcher carried on top of the tracked vehicle in addition to the successful missile firing.

Known as the XM474, the full-tracked vehicle is a product of the Food Machinery and Chemical Corporation of San Jose, Calif. The missile transporter-erector-launcher, TEL, mounted on top of the tracked vehicle, is manufactured by Thompson Air Products Company of Cleveland, Ohio.

The XM474 is a low-silhouette vehicle approximately 17 feet in length, 5 feet in height, and 8 feet in width. It travels at a maximum speed of about 40 miles an hour.

Infrared Tank Devices

Searchlights, periscopes, and binoculars which will enable tank operators to observe the enemy at night by using either visible or infrared light are under development at the Army Engineer Research and Development Laboratories, Fort Belvoir, Va.

The items will form a tank kit consisting of an infrared-visible xenon searchlight, a gunner's infrared-visible periscope, a commander's infrared periscope, and a hand-held infrared binocular. The searchlight is mounted so that it operates in unison with the tank gun. The beam can be varied in width and intensity in either light mode. The xenon searchlight emits infrared radiation which reflects off objects under observation. The periscopes and binoculars detect the reflected rays.

The gunner's periscope has both wide-angle and high-magnification channels using ordinary light and a high-magnification channel using infrared. The commander's infrared periscope provides him with a closed-hatch infrared viewing capability. The hand-held infrared binocular permits open-hatch infrared viewing by the tank commander.

The searchlight was built under contract with the Engineer Laboratories by the General Electric Company, Hendersonville, N. C.; the periscopes by Perkin-Elmer Corporation, Norwalk, Conn.; and the binocular by Wollensak Optical Company, Rochester, N. Y.

First Coherent Light

For the first time a source of "coherent" light—an "atomic radio-light" brighter than the center of the sun—has been devised by scientists of Hughes Aircraft Company, Culver City, Calif. The new "laser" (from light amplification by stimulated emission of radiation) is a solid-state electronic device, smaller than a water tumbler and containing a synthetic ruby as its "heart."

Ruby crystal is heart of laser device.

The radio spectrum is the range of electromagnetic frequencies, starting with commercial radio at 1 million cycles a second and extending into the upper microwave region of 50,000 million cycles. The laser, however, jumps the gap from 50,000 million cycles to 500,000 billion cycles, opening the way for a host of important applications including: (1) True amplification of light (for the first time in scientific history); (2) a new scientific tool for investigating properties of matter and performing basic experiments of physics; (3) focusing light into high-intensity beams for space communications; (4) vast increases in the number of available communications channels; (5) utilization of high light concentration for industrial, chemical, and medical purposes.

Following are the essential steps in its operation:

1. A light source, such as a powerful flash-tube lamp, irradiates a synthetic ruby crystal.

2. The optical energy excites the atoms to a higher energy state from which the energy is reradiated in a narrow band of frequencies.

3. The excited atoms are coupled to an atomic resonator and stimulated to emit the radiation together. This is in contrast to ordinary light sources where the atoms radiate individually at random and is responsible for the incoherence of these latter light sources.

All-Seeing Radar

A radar Cyclops known as Esar (electronically steerable array radar), capable of focusing its electronic eye simultaneously on space vehicles and aircraft at lower altitudes, is being developed by the Bendix Corporation. The electronically steerable feature permits Esar to look at a great number of objects over a wide area at one time, yet it has the ability to concentrate on one object while keeping the other objects in view.

This ability is made possible through the development of a system using multiple electronic search and track beams without the need of moving parts such as are used for the mechanical rotation of a conventional antenna. It will be used to track space vehicles launched from Wallops Island, Va., and to monitor airway traffic in the Baltimore-Washington flight area.

Missileer-Eagle System

The Navy recently selected the Douglas Aircraft Corporation, Santa Monica, Calif., for the development of the Missileer, the launching aircraft for the Eagle long range air-to-air guided missile. The Missileer aircraft will be powered by two TF30-P-2 turbofan engines under development for the Navy by Pratt & Whitney, a division of United Aircraft Corporation.

The Eagle-Missileer weapon system employs the concept of building long range and high performance into the missile, rather than into the launching aircraft. Development of the Eagle missile and its associated fire-control system is already under way by the Bendix Corporation.

Surveillance Drone

A push-button electronic scouting system which for the first time will enable

(*Continued on p. 242*)

AIRESEARCH designs, develops, manufactures and tests a *complete* line of cryogenic valves and controls in individual packages or complete systems for missiles, space vehicles and related ground support equipment.

The superior reliability of AiResearch cryogenic systems and components is backed up by more than 20 years of experience as the largest producer of valves and controls in the aircraft and missile industries. This capability includes liquid and gaseous fuel and oxidizer components and systems operating at temperatures ranging from −420°F. to more than 2000°F.

AiResearch leadership in all of these fields is supported by the most complete cryogenic testing and manufacturing facilities available. All AiResearch missile components are designed and qualified to meet or exceed requirements of military specifications.

Inquiries should be directed to Control Systems, AiResearch Phoenix Division.

1. *Airborne pressure regulator and shutoff valves for propellant tank.*
2. *Airborne check valves.*
3. *Ground-to-missile fill and drain systems for fuels and oxidizers.*
4. *Airborne pressure relief regulator and vent valves for propellant tank.*
5. *Airborne turbo-pump speed sensors.*
6. *Airborne liquid propellant shutoff valves.*
7. *Ground support pressure regulator and shutoff valves.*

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Systems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

966 TRAXCAVATOR—2¾ CU. YD. STANDARD BUCKET • 140 HP Cat D333 Diesel Engine, turbocharged to give extra efficiency and quick response for machine drive and bucket hydraulics. • 57" reach at 7' dumping height . . . maximum lift—12' 10". • LIVE ACTION hydraulics for tough excavation, fast lift and dump. • DUAL-RATIO steering for work and highway travel. Operator shifts lever on steering column to select work or travel ratio. For work cycles and quick turns, one-half twirl of steering wheel puts Traxcavator in maximum turn. For travel ratio, 2 twists of wheel are required for sharpest turn. • DIRECT ELECTRIC STARTING standard. Gasoline starting engine optional.

CATERPILLAR ADDS 2¾ yd. and 1¼ yd. MACHINES

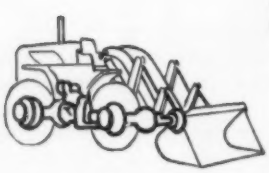
THE 966 and 922

Cat's first wheel loader, the 2 yd. 944, introduced this spring, has already gained an acceptance unmatched in machinery history. Now there's a full line and one for your job: the 966, 2¾ yd., 140 HP, for high production jobs where you measure time in tons of material loaded; the new 922, an 80 HP, 1¼ yd. Traxcavator with all the safety and fast operating features of the two bigger machines. The 922 can give you speed, versatility and production to handle all those jump-and-run jobs.

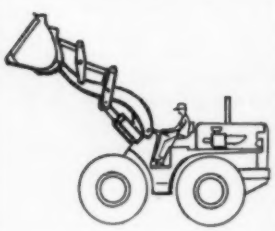
Have you seen a 944 working in your area? Have you asked the owner about its dependability and favorite features? He's probably got some mighty impressive answers. And frankly it's understandable why these Traxcavators have made a name for themselves so quickly. There is a *7-year* history of thorough testing and development behind these *new* machines. They come from the manufacturer with 23 years' loader experience and 20 years of wheel tractor know-how.

Look at the features that are on all 3 loaders: clean, open cockpit, easy to get into; bucket arms up front away from the operator; well-balanced design; long dumping reach (nearly 5' on the 966), soaring lifts to get over truck sides

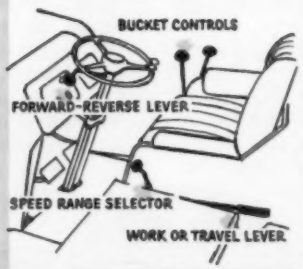
Both the 966 and the 922 have all the features proved in the field by the popular 944 Traxcavator



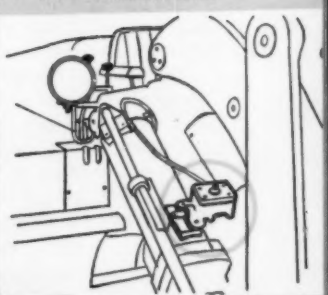
POWER SHIFT TRANSMISSION with torque converter gives smooth, instant shifting for 1st-2nd speeds—forward and reverse. In travel range, the machine is in 2-wheel drive for high-speed roading. A shift to work range automatically puts power to all 4 wheels for full traction.



OPERATOR SAFETY Lift arms and cylinders are all forward of the cockpit . . . giving complete freedom of movement. Visibility is excellent at all times. It's easy and safe to get into a Traxcavator from either side . . . up 3 wide steps . . . no ladders to climb. Tires are covered by fenders.



OPERATOR CONVENIENCE Bucket controls are on the right side, leaving the left hand free for machine operation. The forward-reverse lever is mounted on the steering column for finger-tip shifting without decelerating, steering is power boosted with dual-ratio on the 966.



AUTOMATIC BUCKET KICK-OUT DEVICE allows faster cycles. After loading bucket, pull lift lever to up position. Bucket goes up to dumping height and control kicks into hold position automatically. While lowering bucket after dumping, set tilt lever, and bucket is positioned for digging.

922 TRAXCAVATOR—1¼ CU. YD. STANDARD BUCKET • 80 HP. Your choice of compact 4-cylinder Caterpillar turbocharged Diesel Engine (uses low-cost furnace oil without fouling) or 6-cylinder gas engine with large cubic inch displacement for long life and sustained power. Use the type of engine that matches your other equipment. With either engine you have one source of warranty responsibility . . . one source of parts and service . . . your reliable Caterpillar Dealer. • Long 40¾" reach at 7' dumping height . . . maximum lift of 11' 2". • For top production in its class, the new 922 Traxcavator has all the safe, fast operating features of the bigger machines.

TO ITS WHEEL LOADER LINE...

TRAXCAVATORS

and railroad cars; automatic bucket controls to speed cycles; dependable Cat Diesel power with optional gasoline engines on two smaller models; Cat power shift transmission to change speed and direction with a finger touch, without decelerating; and service features like the dry-type air cleaner and unitized construction.

There's one man in your area with all the facts — your Caterpillar Dealer. Get in touch with him now. Ask for a demonstration — once you watch one of these machines you'll want it!

Caterpillar Tractor Co., General Offices, Peoria, Ill., U. S. A.

CATERPILLAR

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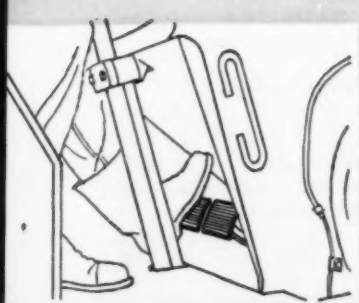
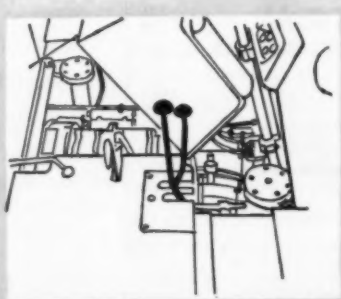
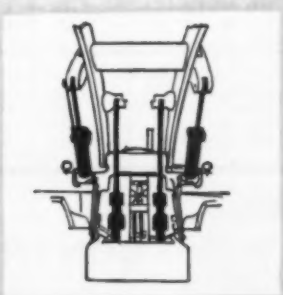
TRAXCAVATORS ARE MAKING OTHER LOADERS OBSOLETE



DUAL BRAKES The left brake pedal neutralizes the transmission as it stops the machine. This transfers extra power to the bucket . . . assuring full loads even in tough material. The right brake pedal stops the machine with the transmission engaged . . . giving full control for roading downhill.

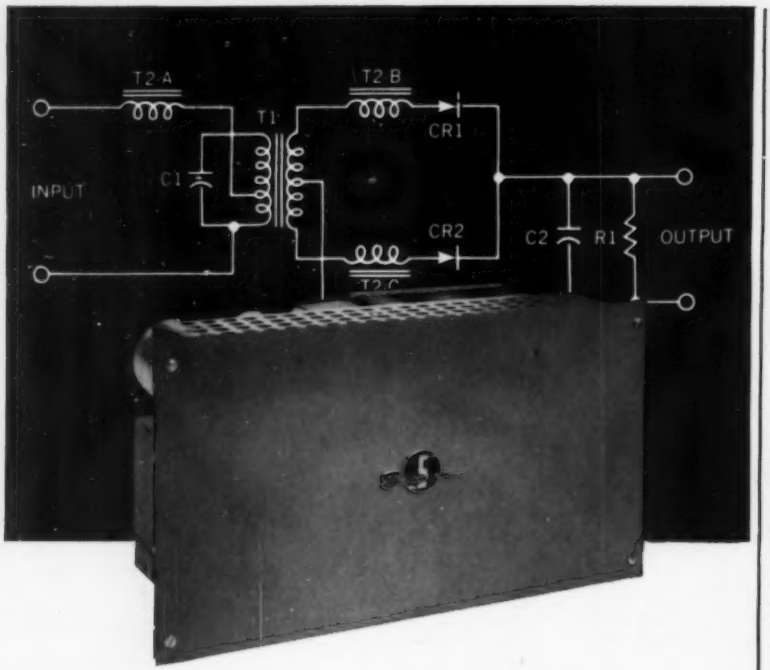


EASY SERVICE ACCESS The seat tips forward for quick access to transmission oil filter and control linkage adjustments. Unit construction allows independent removal of engine, transmission, other major components. The dry-type air cleaner can be serviced in about 5 minutes.



LIVE-ACTION HYDRAULIC SYSTEM Plenty of power from the engine is always available to the husky vane-type pump that supplies the pressure and volume for fast bucket action. Control valves are enclosed in the steel reservoir for complete protection. System is full-flow filtered.

AVAILABLE WITH A COMPLETE LINE OF ATTACHMENTS, including special buckets for light or heavy materials, lift forks for lumber and palletized materials, and the exclusive side dump bucket. A fiber-glass cab is also available.



MD simplicity means savings for you

Here's a line of d-c power supplies you can literally mount in your relay rack and forget . . . the ultimate in simplicity and reliability. It's Sorensen's MD series featuring rugged magnetic regulation, heavy-duty silicon rectifiers, conservative continuous-duty ratings for all components. Output voltage holds to ±1% for input variations from 100 to 130 vac. 132 stock models from 3 to 1000 vdc output, 50 to 3000 watts (see table for just a few typical ratings). Several units may be used with paralleled outputs for increased capacity up to 9000 watts. Current limiting characteristics particularly suit MD's for battery charging and filament powering . . . can't be damaged by output shorts.

Write for complete MD data . . . Or, better, send for the new Sorensen catalog, listing over 400 power equipment models, plus the name of your Sorensen representative. Sorensen & Company, Richards Ave., South Norwalk, Conn.

POPULAR MODELS AND PRICES

(Numbers preceding dash in model designation indicate output voltage; those following dash indicate maximum current.)

Model	Price	Model	Price	Model	Price
50 watt		200 watt		750 watt	
MD 6.3–8.0	$159	MD 6.3–31.8	$257	MD 6.3–120	$523
MD 12–4.2	145	MD 12–16.7	215	MD 12–62.5	423
MD 28–1.8	137	MD 28–7.2	184	MD 28–26.8	336
MD 48–1.1	131	MD 48–4.2	179	MD 48–15.7	315
100 watt		400 watt		1500 watt	
MD 6.3–15.9	$194	MD 6.3–63.5	$348	MD 6.3–239	$921
MD 12–8.4	171	MD 12–33.3	292	MD 12–125	735
MD 28–3.6	158	MD 28–14.3	247	MD 28–53.6	567
MD 48–2.1	152	MD 48–8.4	231	MD 48–31.3	525

0.33

Sorensen CONTROLLED POWER PRODUCTS

A SUBSIDIARY OF RAYTHEON COMPANY

. . . THE WIDEST LINE MEANS THE WISEST CHOICE

New Developments (Contd.)

battlefield commanders to learn instantly what is going on in enemy territory, was disclosed recently by the Army.

The system consists of advanced ground and airborne equipment and an unmanned, jet-powered combat surveillance drone which sends back information while in flight. It will operate day or night, under all weather conditions, and will not be fooled by camouflage. Flying at low altitudes and at high speeds, the turbojet drone cannot be stopped easily by enemy action. It can remain over enemy areas for extended periods, and may be recovered and reused.

Designated the AN/USD-5, the system is being developed with the Army Signal Corps by Fairchild Engine and Airplane Corporation of Hagerstown, Md.

Mach 20 Shock Tunnel

An ultrahigh-pressure, combustion-driven, Mach 20 shock tunnel is scheduled for completion in September at Republic Aviation Corporation, Farmingdale, N. Y. The facility, believed to be one of only two in the United States utilizing pressures to 100,000 p.s.i., has been designed by and is being fabricated and erected on location by the FluiDyne Engineering Corporation, Minneapolis, Minn., prime contractor.

The tunnel will test models of missile components and materials to further the study of aerodynamic and heat-transfer problems related to reentry and high-speed flight.

Restartable Rocket Engine

Bell Aerospace Corporation recently overcame one of the major problems associated with space ventures—development of a rocket engine that can be turned off and on at will to control the position and direction of space craft.

Designated the Bell 8081 engine, it is an advanced version of the model used in the current Discoverer satellite vehicles.

Restart capability would make it possible for a satellite in orbit to reuse its final-stage engine for return to earth or to change its orbit and also to employ the engine for controlled landings.

Vantage-Point Radar

A new portable radar system which is designed to look far behind enemy lines and provide photographic plots of battle information has been developed for Army combat troops. The system will sweep enemy-held territory in a 25-mile semicircle and by periodic photo plots help determine whether enemy buildup or attack is impending or a withdrawal is in progress. It will also detect deployment and patterns of movement and provide widespread and accurate detection of enemy movement.

The vantage-point radar works on the

navigation and control equipment by SPERRY

SHIP'S INERTIAL NAVIGATION SYSTEM (SINS) – A complex of precision gyros, accelerometers, integrators . . . continuously measuring position, heading, pitch-and-roll, drift, speed, earth's rotation.

GYRO-COMPASS – The Mark 19, a highly accurate directional reference for ship navigation and automatic steering system, and a precise vertical reference for fire control and target surveillance. The Mark 23, smaller, rugged, reliable, undetectable and unjammable as is the Mark 19, and like it designed for thousands of hours of operation as both a directional and North-seeking compass.

STABILIZED PERISCOPE SEXTANT, able to take fixes through periscope and calculate the exact altitude of moon, sun or stars . . . then to compute the angle of sighting to provide for a pinpoint "fix" anywhere in the world.

AUTOMATIC COURSE AND DEPTH KEEPING CONTROLS, for holding an undeviating course, at any unvarying depth, for long periods of time.

STEERING AND DIVING INSTRUMENTATION–Provides a readout panel for automatic steering system and dials for making fine adjustments to it.

SHIP'S DEPTH DETECTOR, senses depth of the ship and displays information on the indicator.

This is the Sperry equipment which was aboard the USS TRITON when she made history by completing the world's first underwater circumnavigation of the globe in 84 days, covering 41,500 miles.

The accuracy and dependability of this submarine equipment is typical of all Sperry navigational aids whether designed for Naval surface vessels, luxury superliners or small work boats. General offices: Great Neck, N. Y.

Environmental conditioning

for missile guidance systems

AiResearch Gyro Conditioners for the U.S. Army Sergeant missile are the most complete and efficient systems of their type.

The 8 lb. package, consisting of heat exchanger, heater, thermal switches and three fans, maintains a hermetic atmosphere of 85°F. to 160°F. in an outside ambient temperature of —20°F. to 140°F. Even temperature levels throughout the electronic compartment are maintained by an internal fan and low velocity air movement.

AiResearch is the leading designer of such advanced electronic conditioning equipment and systems, and this production unit is but one example of many produced for missile and ground support applications.

When fast attention to your problem, high reliability and small unit size and weight are important, contact AiResearch first.

Environmental conditioning equipment has been produced for the following electronic systems: **Detection • Communication • Control • Ground Support • Guidance**

Write for literature today.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

New Developments (Contd.)

doppler principle, which detects slight movements toward or away from the radar because of the change in frequency of the radio waves reflected from the moving objects. The entire system, including antenna, weighs approximately 600 pounds. The antenna is somewhat larger than those used by orthodox battlefield radars, allowing the use of a low-frequency scanning signal which has improved brush and foliage penetration. The system is officially designated as the AN/TPD-2.

New Regulus I Guidance

The Navy has awarded a $3,500,000 contract to Chance Vought Aircraft for installation of an electronic guidance system in Regulus I, the Navy's surface-to-surface guided missile. The new system, which will supplement the missile's radio-command control system, will give the weapon greater accuracy.

The missile, which has been launched successfully nearly 1,000 times from submarines, surface ships, and land sites, will be converted at Navy bases using electronic kits supplied by the company.

Underwater Storage

An experimental underwater storage system that would give the armed forces strategically located fuel and supply depots in any predetermined ocean area at comparatively low cost recently was installed in the Gulf of Mexico. The experimental underwater storage facility consists of a series of interconnected nylon-reenforced rubber tanks which could be filled or emptied by tankers.

Officials of many shore line municipalities also have expressed an interest in the underwater storage system for use in possible emergencies. In the event the tanks are used for storage of food, medical supplies, or other products, entry would be made through airlocks.

Polaris Trainer

The first production model Polaris fire-control trainer has been delivered to the Navy by the General Electric Company. Designed to train crews aboard fleet ballistic missile submarines, the electronic device permits simulated submerged launchings of the intermediate-range Polaris missile. The computerlike trainer can be connected to the fire-control system of the submarine, allowing its attack party to practice complete launching operations on the same equipment that would be used to fire an actual missile.

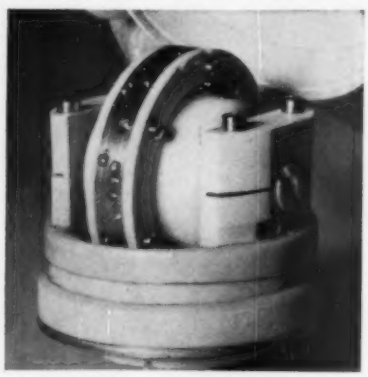
Army Research Reactor

An agreement recently was signed between the Army's Diamond Ordnance Fuze Laboratories in Washington, D. C., and the General Dynamics Corporation, authorizing construction of a nuclear research reactor capable of providing short pulses of intense nuclear energy for the study of radiation effects on components of military equipment.

The reactor, specifically designed to minimize the possibility of radiological hazard in operation, will be installed next year in the Forest Glen section of Walter Reed Army Medical Center, Forest Glen, Md. The new reactor and its associated test facilities will be known as the Diamond Ordnance Radiation Facility.

Ceramic Gyroscope

The aerospace industry's first ceramic gyroscope, said to represent a tenfold improvement in gyro accuracy, has been developed by the Aeronautical Division of Minneapolis-Honeywell Regulator Company.



Ceramic spin motor of new gyroscope.

It is claimed that the combination of ceramics and gas bearings sharply reduces the prime causes of gyro drift inaccuracies and results in a gyro with a theoretical life span approaching infinity. The ceramic bearings in the new gyro are lubricated by a film of gas only 25 millionths of an inch thick. The film of gas, while virtually friction free, is under pressure that is stiffer than the steel bearings it replaces. At the same time vibration, or bearing noise, is decreased by a ratio of thirty to one.

Titanium Rocket Case

Aerojet-General Corporation recently made and successfully fired a full-scale third-stage rocket motor for the Air Force Minuteman missile using a case made entirely of lightweight titanium. This is the first time titanium has ever been successfully demonstrated in a large rocket motor and is seen as a major break-through in solid-propellant technology. The program was conducted under an Air Force contract and is the culmination of years of effort in research and development by the various services. The titanium case compensates for its extra cost by its light weight which provides significant range increases over steel chambers.

MATERIALS PROGRESS

George S. Brady

Ceramics in Space.—Greatly increased stability and accuracy are attained by the use of ceramic in the spin motor, bearings, and gimbal of a new design of space-guidance "MIG" (miniature integrating gyroscope). Ball bearings have been eliminated. The ceramic shafts of the spin motor serve as the bearings, riding on ceramic races and lubricated by a helium gas film 0.000025-inch thick.

The gas is under pressure, making it stiffer than the steel balls it replaces, and vibration and bearing noise are stated to be decreased in a ratio of thirty to one. Tests of the unit at temperatures from minus 85 to plus 1,500 degrees Fahrenheit indicated dimensional stability within 0.000002-inch, and practically no wear has appeared after thousands of test starts and stops.

Flotation of the gimbal on a gas bearing gives a 99 per cent-plus gas suspension, and reduces friction to near zero. The spin-motor stator is encapsulated with glass. The gyro parts are cast from aluminum-oxide powder and fired to a "green" state for machining. The final firing at 3,200 degrees Fahrenheit gives uniformly dense, extremely hard parts which are finish-ground with diamond compounds to a tolerance of 0.000003-inch. The MIG unit, as produced by *Minneapolis-Honeywell Regulator Company*, is 2.75 inches long, 2.812 inches in diameter, and weighs 8 ounces.

The nose cone of the Navy Sparrow III guided missile is also made of aluminum-oxide ceramic. *Aluminum Company of America* engineers point out that, in addition to resistance to heat shock and high-speed erosion, the alumina ceramic is transparent to radar waves, and the waves are not distorted in passing from the electronic guidance system.

New Alloy.—Molding of ceramic electronic parts at very high pressures and temperatures above 2,200 degrees Fahrenheit, particularly large parts of 30 or more square inches of surface area held in the mold for long cycle periods, has caused problems of erosion and rapid failure of the molds. *Gulten Industries, Inc.*, Metuchen, N. J., has been using an alloy of 45 per cent nickel, 22 chromium, 9 molybdenum, 0.15 carbon, and the balance iron (Hastelloy X of the *Haynes Stellite Company*). Molds of this alloy have shown practically no deterioration after seventy 4-hour cycles.

Progress in Batteries.—Requirements for rockets and missiles have brought rapid advancement in electric battery power units in a relatively short time. The dry-cell battery used during World War II was little different from the Gasner cell of 1888 based on the LeClanche zinc-carbon-manganese oxide battery of 1868. The first improvement after the war was to produce a uniform synthetic oxide that would give better shelf life, but this battery was good only for low-drain intermittent use such as in flashlights, and gave poor performance in radios or for instrument motors.

The first satellite launched in January 1958—Explorer I—had a zinc-mercuric oxide battery. This battery gave the same energy as the LeClanche cell in one-third the space, and had the advantage of a flat voltage curve during discharge. But action was poor at low temperatures and it needed a heater. The Tiros, launched in April of this year, used a solar-energy converter with a nickel-cadmium battery for storage and direct power use. The maximum energy of sixty watt-hours per pound is about fourteen per cent less than that of the LeClanche cell, but it is good for low temperatures.

But a rechargeable battery that must depend on an outside power source for long life was not a complete answer for electronic requirements. Further research has been taking a number of directions. A magnesium-manganese oxide cell developed by the Army Signal Corps has a much higher maximum energy than the old LeClanche cell and operates at a 0.1- to 0.3-volt higher level. It also has a longer shelf life, but it has the same dropping-voltage curve in use.

Another Signal Corps battery that looks promising, and which would free us from dependence on the "strategic" manganese dioxide, is the magnesium-organic cell. Not much information has been published on this new development, but it apparently can be made up in various ways. One combination is Mg/Mg $(ClO_4)_2$/meta dinitro benzene. (*Continued on p. 246*)

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

Environmental conditioning

for missile ground support systems

AiResearch electronic cooling units for U.S. Army Hawk missile mobile ground radar equipment require only half the space originally allotted. These lightweight production units, with a heat rejection capacity of 10 KW, measure 20″ x 24″ x 24″.

A complete system package, the liquid-to-air unit includes an accumulator, pump, heat exchanger, fan, switches and valves.

Contact AiResearch early in your planning and design stage for greater reliability, smaller unit size and weight. AiResearch is the leading designer and manufacturer of advanced electronic conditioning equipment and systems for missile and ground support applications.

Environmental conditioning equipment has been produced for the following electronic systems: **Detection • Communication • Control • Ground Support • Guidance**

Write for literature today.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

a new concept for ordnance safety in missiles and space vehicles...

LIBRASCOPE
EBW
EXPLODING BRIDGEWIRE SYSTEM

- Rocket Motor Initiation
- Thrust Termination
- Stage Separation
- Destruct Units
- Replacement of squib or detonator for any ordnance application

Unprecedented safety during the entire stockpile-to-target sequence characterizes Librascope's EBW System for ordnance initiation.

Aboard the vehicle, EBW's virtual immunity to premature initiation makes it possible to eliminate elaborate safing mechanisms. Weight of multi-stage missiles and space vehicles can thus be significantly reduced.

Of prime economic importance is the versatility of the Librascope EBW System. For one EBW flight firing unit will properly sequence and initiate all ordnance components in a complete missile system.

Designed and developed by Librascope's Sunnyvale Branch, the EBW System utilizes the energy produced by the exploding wire to directly initiate an insensitive secondary explosive. EBW initiators of this type cannot be initiated by stray DC potentials or high-energy RF fields.

Send for EBW Brochure to Librascope Sunnyvale Branch, 670 Arques Ave., Sunnyvale, Calif.

LIBRASCOPE DIVISION
GENERAL PRECISION, INC.

Materials Progress (Contd.)

Titanium Anodes.—*Crucible Steel Company*, Pittsburgh, Pa., is offering titanium anodes plated with a thin coating (0.0001-inch) of platinum to replace consumable anodes of graphite or nonconsumable platinum anodes for such electrochemical processing as chlorine-caustic cells. The new anodes eliminate contamination of the cells which occurs with consumable anodes, and saves expense of the solid platinum anode. With graphite anodes there is a power loss as the anode wears down.

Manganese Production.—In announcing a large increase in its electrolytic manganese capacity, *Union Carbide Metals Company* calls attention to the increasing use of high-purity manganese metal (99.9-plus per cent purity) in the making of high-temperature alloys, resistance alloys, stainless steels, and nonferrous alloys. The atomic and electronic industries are demanding steels and alloys of a purity and controlled composition far beyond anything called for a few years ago.

The low-silicon and low-carbon contents of the electrolytic manganese metal also have made it a requirement in the production of deep-drawing and other special steels of closely controlled specifications. Since electrolytic manganese can be made from low-grade ores, the increasing demand for the higher-cost grade should be a spur to further development of our plentiful domestic low-grade manganese ore resources.

Furane Pipe.—Use of the highly chemical resistant furane plastics until recently has been largely limited to coating for chemical equipment and for acidproof masonry cements because of the dark color and previous high cost. But now, *Cornelius A. Rauh & Associates*, Akron, Ohio, is producing 7 sizes of furane pipe for carrying hot acids, alkalies, and corrosive liquids at temperatures to 300 degress Fahrenheit and pressures to 150 pounds per square inch.

The material used is furfural alcohol resin (Durez 16470 of the Hooker Chemical Company). The pipe is strong, dimensionally stable, does not sag in long lengths, and the low coefficient of friction gives a twenty per cent greater flow rate than steel pipe. It can be steam sterilized, and is suitable also for outdoor use. The pipe, called Eonite, is produced by extruding one thickness, applying an angular wrapping of woven borosilicate glass fabric, and then extruding an outer coating of the resin.

Black Glass.—*Corning Glass Works*, Corning, N. Y., has developed a black glass for use in enclosing light-sensitive electronic components. The glass retains the physical properties of standard clear glass, but will filter out the ultraviolet and near-infrared wave lengths as well as the visible light. Composition of the glass is not given, but specification by composition is a dubious way of ordering glass today, anyway, since glass making has become a highly specialized technical art with tens of thousands of possible combinations, and best results can be obtained by specifying the requirements of the job.

Nylon in Lubrication System.—A new automatic lubrication system for metering and delivering the right amount of lubricant under constant pressure automatically to all points in an automobile or truck uses nylon for the translucent lubricant reservoir, the molded manifolds, meter holders, plugs and sleeve fittings, and for all the tubing. The plastic used is Nylon 6, produced by the *Spencer Chemical Company*. Nylon 6 is made from caprolactum, $(CH_2)_5NH{\cdot}C{:}O$, and has a single 6-carbon ring. It has light weight (specific gravity 1.14), is heat and chemical resistant, and is strong and tough with a tensile strength of 11,700 pounds per square inch and an elongation of 70 per cent.

Wire Filters.—Porous metal filters with higher strengths and greater modulus of elasticity than ordinary porous metal filters made by powder metallurgy are being produced by the *Bendix Corporation*, located at Madison Heights, Mich., in the forms of cylinders, cones, and other geometrical shapes. They are made from single or stranded wires wound in layers and welded at the contact points by furnace sintering. Any diameter up to 40 inches can be made, and pore sizes are from 10 to 50 microns. Metals are selected to suit the corrosion conditions.

Pure Iron Powder.—A very pure grade of iron powder produced by the *Alan Wood Steel Company* under the name of H-iron is made by the hydrogen reduction of magnetite, Fe_3O_4, iron ore. Reduction is carried out at high pressure with a temperature below 1,000 degrees Fahrenheit to prevent sintering of the iron particles. The powder is pyrophoric as it comes from the reducer. To make it nonpyrophoric it is heated in a nonoxidizing atmosphere.

Polypropylene Resin.—*Enjay Company*, New York, N. Y., is now in production on three viscosity grades of polypropylene resin for high-speed precision molding. The plastic, called Escon, has a density of 0.902, melting point of 335 degrees Fahrenheit, yield strength of 4,700 pounds per square inch, elongation of 15 per cent, Rockwell hardness of R85, and dielectric strength of 660 volts per mil. This appears to be the first time that this new type of resin has been put into continuous-process production in this country.

Arming America's Pentomic Army. Global commitments . . . daily readiness . . . combat capability by the hour. These shape the needs of our new Pentomic Army. Its ordnance must match the coiled-spring readiness of this flexible striking force. Avco's Crosley Division is working with the Army to develop a variety of such new and sophisticated ordnance. These activities cover a broad portion of the ordnance spectrum and include arming and fuzing, ballistics, projectiles, microminiaturized electronic assemblies, and many others.

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Materials Progress (Contd.)

Lightweight Equipment.—As Maj. Gen. F. W. von Mellenthin pointed out in ORDNANCE (July-August 1960), modern weapons are quite able to pierce the strongest and thickest armor, so that accent in the future will be more on lightness, firepower, and mobility than on armor. This puts aluminum in a much more forward position than ever before.

Nine tons of aluminum were used in the construction of the Army Larc-15, the new amphibious lighter with higher speeds on both land and water than any previous amphibian. Built by the *Borg-Warner Corporation*, Kalamazoo Division, it has a carrying capacity of fifteen tons, opening at one end to form a loading ramp for vehicles. Aluminum alloys 5083 and 5086 (high magnesium) were used for the sheet, plate, and extrusions.

Aluminum Boats.—Aluminum alloy 5086, with up to 4.5 per cent magnesium and 0.70 manganese, also is being used widely in marine construction since stronger welds can be made than in the heat-treatable alloys. A "boat fever" has recently struck the American public, and it is estimated that more than seven million families now have boats. More than a third of these boats are of aluminum, and about half the engines are all-aluminum.

Usually, civilian products profit most from military research and development, but the reverse may be true of boats. A number of exotic designs made for sportsmen and for special purposes have features that might be readily adapted for military uses, both for speed and for ability to skim over mud and grass in shallow waters. However, most Navy vessels now use aluminum in superstructures and equipment.

New Mine Cars.—In the 17-ton mine cars built by the *Watt Car & Wheel Company*, Barnesville, Ohio, for service in West Virginia coal mines, aluminum alloy 6061-T6 was used. This alloy has 1.2 per cent magnesium and 0.80 silicon, with smaller amounts of copper, manganese, zinc, titanium, and chromium. It has a high yield strength, 35,000 pounds per square inch. It is more adapted to riveting than to welding, but the cars were satisfactorily tack-welded. For attachment of the trucks and draft gear, aluminized steel carriage bolts were used.

A thirty-five per cent saving in weight was made in the cars, and ten per cent more loaded cars are added to a train without increasing gross train weight. But the most notable saving has been in maintenance costs. There is no corrosion, and dumping is easy, while the rust and corrosion which build up on steel cars in the damp underground operation have to be chipped out frequently.

Aluminum Rails and Chain.—Two million pounds of aluminum will be used in the thirty-five miles of guard rails and posts along the Belt Parkway and Van Wyck Expressway on Long Island. The New York State Highway Department engineers state that tests have indicated that the aluminum, without painting, is unaffected by the seashore air which is highly corrosive to steel and that the new rails will eliminate the "dangerous and costly job of maintenance on busy superhighways." About 35,000 feet of 8-foot aluminum chain fence will also be used on these two roads.

For service where a metal chain is needed that will keep free of corrosion and is nonsparking and nonmagnetic, *Bison Aluminum Chain Company*, Buffalo, N. Y., is now producing a strong seamless and weldless cast-aluminum chain in six sizes from ¼- to 1-inch cross-section diameter. The alloy used has a tensile strength of 40,000 pounds per square inch.

New Powdered Metals.—Under a Navy contract the *National Research Corporation* is conducting research into the production of superfine powders of the high-melting metals, such as molybdenum, tantalum, and columbium. The company already has been successful in producing powders with particles of only a millionth of an inch in diameter. These fine powders produce alloys and sintered parts of superior physical properties, and they are also wanted for use in suspensions, in plastics, and for producing superhard and heat-resistant intermetallic compounds.

New Crystal Growth Method.—With a new vapor-growth method of growing semiconductor crystals of germanium or silicon, sponsored by the *Army Signal Corps*, it is expected that a much lower-cost production can be worked out, and that, since the process is by molecular layers, the "doping" can be done simultaneously to give a controlled amount of the doping metal throughout the crystal. Under present methods, the doping metal is largely concentrated at the surface of the semiconductor crystal. Information so far given out is that the method is essentially by means of the disassociation of an iodide in a vacuum.

Titanium Cladding.—*Titanium Metal Corporation of America* has developed a "do-it-yourself" method of welding titanium to steel to produce duplex metal for tanks and processing vessels for the chemical and foodstuffs industries. Vanadium, which is compatible with both steel and titanium, is used as the junction metal. For spot or seam welding, thin vanadium foil is used between the steel and the titanium. In some cases, plugs of vanadium are inserted in drilled holes in the steel, and fusion welded.

ALPHA CAPABILITIES

Systems competence in design, implementation, structural construction, installation, operation, training, and maintenance of:

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2. *Transportable electronics systems*

3. *Instrumentation, control, and switching systems*

4. *Telecommunications systems*

5. *Integrated land, sea, and air communications systems*

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Alpha CORPORATION

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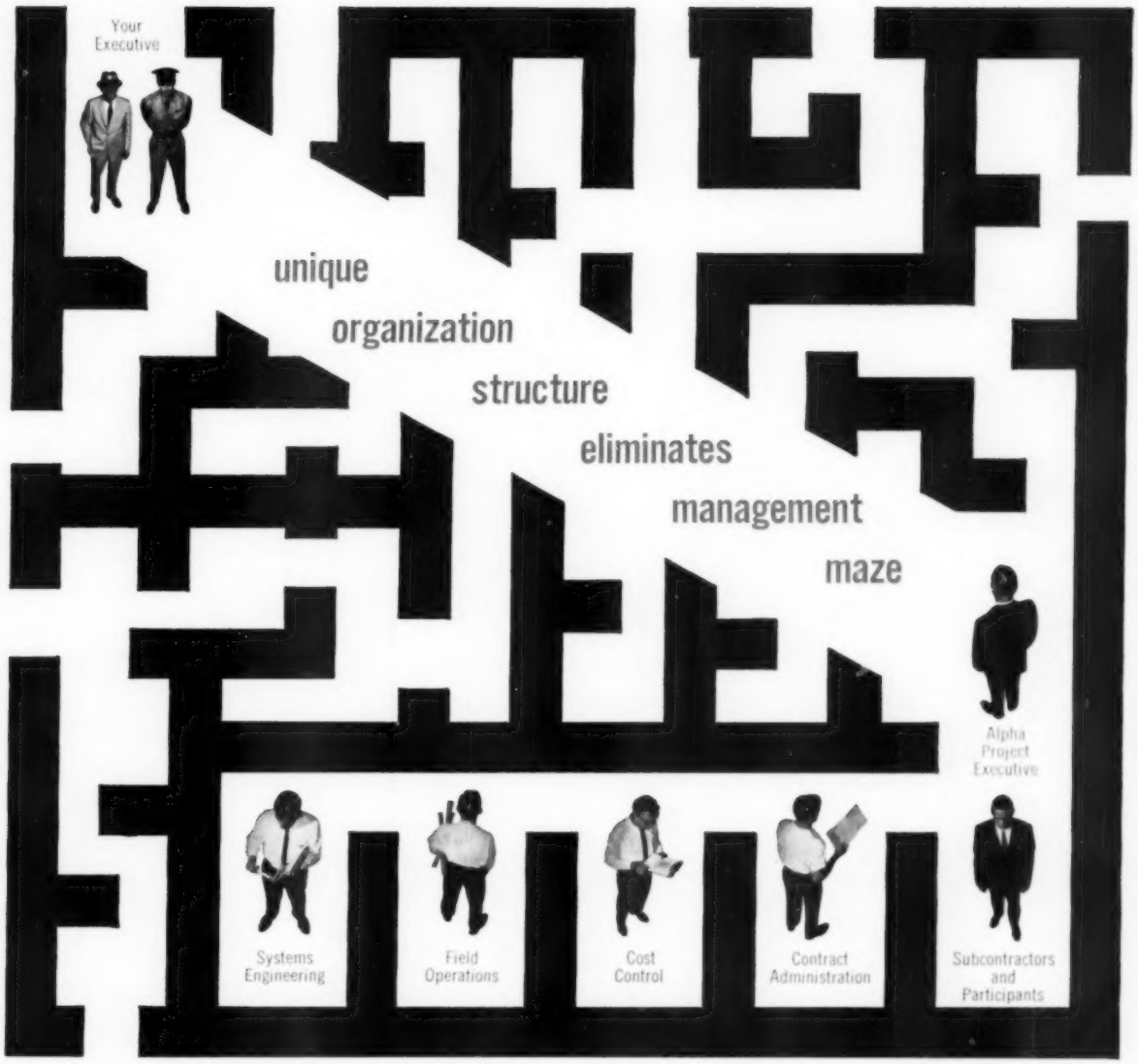

Alpha provides positive systems project execution

Alpha's Project Executive deals directly with the customer and has complete authority, responsibility, and accountability for the timely execution of the project. This unique organization structure provides complete coordination of systems management and engineering within the assigned project division. It provides your executive and Alpha management with quick, direct access to the facts on project status and performance.

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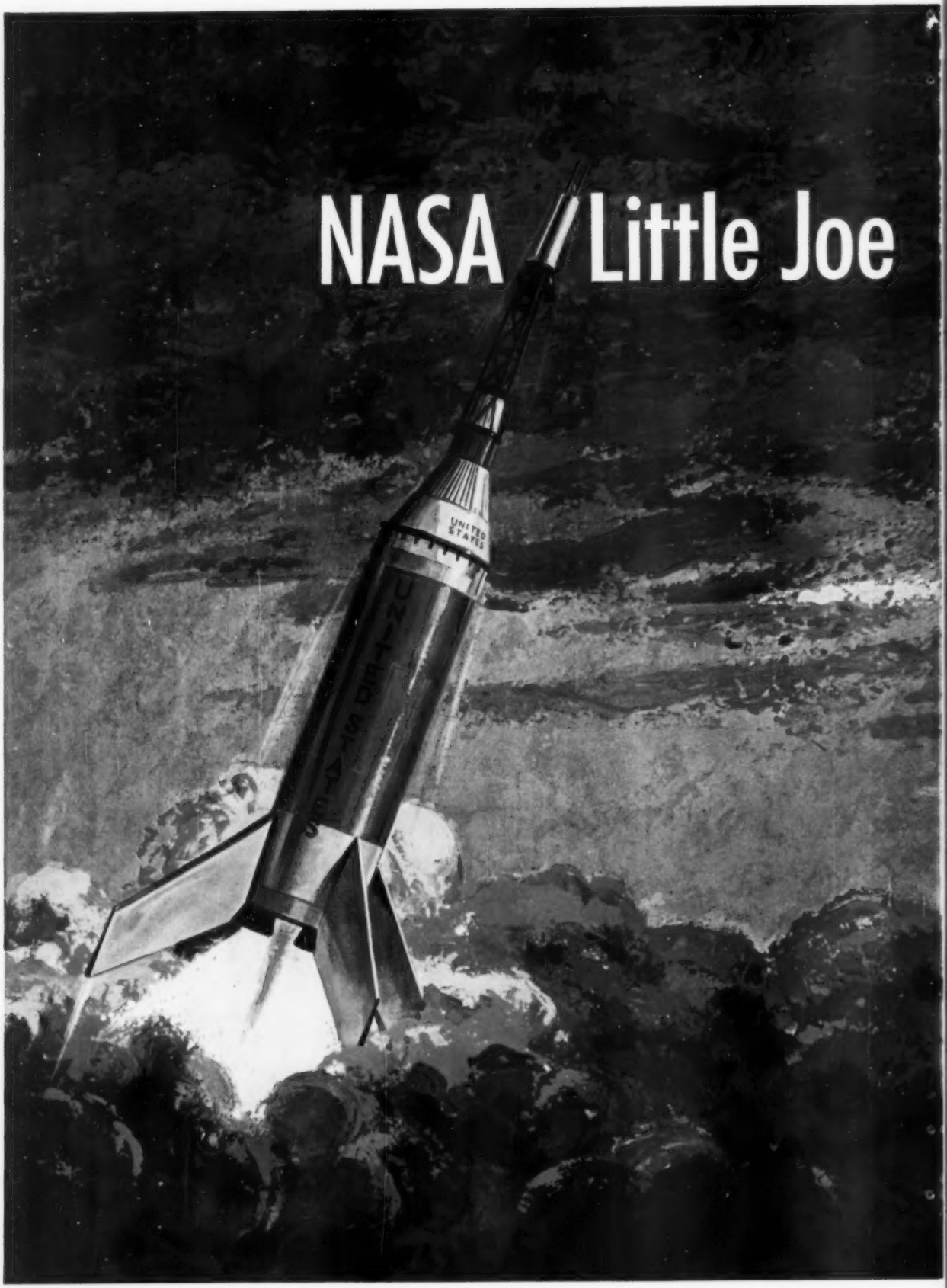

NASA / Little Joe
UNITED STATES
UNITED STATES

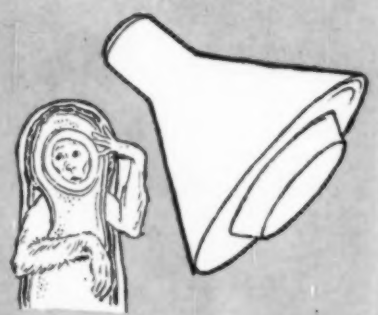
Consistently successful flight performance in Project Mercury confirms unsurpassed reliability of THIOKOL solid rocket motors.

Time after time, NASA's workhorse, Little Joe, has soared into space, checking out the workability of materials, propulsion and escape systems, and reaction of research animals to the environment of space flight.

Pollux, Recruit, Castor—solid rocket motors from THIOKOL's Elkton and Redstone Divisions—have unfailingly provided the thrust and power for Little Joe in its developmental flights.

THIOKOL's record of propulsion reliability in the spatial program is long and brilliant, reaching back to the X-17 which flew successfully in 96% of its launches, and to earlier research vehicles.

In NASA's Little Joe series, THIOKOL booster motors in various configurations have developed up to 250,000 lbs. thrust, today's ICBM class. Smaller THIOKOL rockets have been used to free escape capsule from booster.



Little Joe has carried this research and development capsule and research animals to varying altitudes to obtain engineering and medical data prior to launching man into orbit with subsequent safe recovery. The reliable THIOKOL solid rocket motors used in these missions are virtually off-the-shelf items and are available to other research groups.

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SPLIT—SECOND INFORMATION

An effective Army must have split-second, exact combat intelligence. Republic's Missile Systems Division is working on one means of fulfilling this need for the U. S. Army with the AN/USD-4 Swallow system: a completely integrated ground-airborne information-gathering system.

The SD-4 system includes an all-weather, jet-powered surveillance drone, mobile ground command and information stations, and associated ground support equipment. The drone will be field-launched and employs any of a number of surveillance sensors. This high-performance unit will permit the field army commander to extend his view beyond the horizon to gain up-to-the-minute information. Its mission completed, the SD-4 will return, be recovered and readied for a new mission.

The airborne-ground SD-4 Swallow system was designed and is being developed by Republic's Missile Systems Division under contract to the U. S. Army Signal Corps.

REPUBLIC AVIATION

MISSILE SYSTEMS DIVISION

FARMINGDALE, LONG ISLAND, N. Y.

ARMAMENT ELECTRONICS

W. H. Van Vliet

Space Power.—The National Aeronautics and Space Administration will negotiate a contract with Thompson Ramo Woolridge Inc. for development of a 3-kilowatt solar-mechanical space auxiliary power system which will weigh 700 pounds and operate for one year.

Called Sunflower, the system will use a collapsible, petal-type paraboloid reflector to collect the sun's rays and focus them on a boiler. The heat will vaporize mercury in the boiler to drive a turbogenerator. The mercury vapor is condensed and reused. The system will include a thermal storage unit to provide heat for the system while the vehicle is in the earth's shadow.

Underwater Communications.—The Navy is sponsoring study by several companies in underwater communications. The technique would permit Polaris submarines and other submersibles to communicate with each other and with aircraft. One method, secure submarine communications (Sesco), is a system of voice-modulating sonar. Sesco is an outgrowth of the Navy's older Gertrude system.

New Van Allen Belt.—According to research being sponsored by the Office of Naval Research, California Institute of Technology scientists have almost conclusively established the existence of a Van Allen type radiation belt around Jupiter. The belt, many times stronger than the one around the earth, is believed to be about 200,000 miles above the planet's surface and is approximately 400,000 to 500,000 miles wide, in a direction parallel to the planet's equator.

Air Defense Systems.—The Army Signal Corps' mobile "vest-pocket" electronic air defense system, the AN/MSQ-18, which coordinates firing of Hawk and Nike guided-missile batteries, has been deployed in several NATO countries in Europe. Produced by Hughes Aircraft Company, the system enables an air-defense commander at battalion level to control and coordinate missile batteries even though they may be strategically dispersed over a wide area.

In the system, the battalion commander is given information on the tactical situation within his area by means of display console equipment in a mobile operations central. The system can coordinate four or more Nike or Hawk batteries against enemy aircraft attempting to enter a field army's zone of defense.

The system is operational on a 24-hour basis in any weather and is miniaturized to fit into standard 2½-ton Army trucks, making it operational wherever these vehicles can be driven. To provide a larger air-defense system, the vest pocket system can be linked together to form a Missile Monitor. Several Missile Monitors may in turn be linked to provide over-all theater coverage.

Thermoelectric Generator.—A 5-kilowatt thermoelectric generator has been developed for the Navy by Westinghouse Electric Corporation. The generator, largest of its kind, is made up of two 2,500-watt subgenerators, burns kerosene, and operates at 1,200 degrees Fahrenheit. The only moving parts are pumps for cooling water and fuel.

Airborne Computer.—An airborne computer system, designed to give Navy fighter and attack aircraft submarine detection capability, is under development by Douglas Aircraft Company. The system is compatible with Julie sonobuoy units which are dropped from aircraft to pinpoint a submarine's position once its general locale is known. The computer system, Julie automatic sonic data analyzer (JASDA), will be carried in external pods to receive and interpret information from the Julie sonobuoys. A similar system currently is being produced by Grumman Aircraft Engineering Corporation.

Earth Communications.—A new concept for weapon-system communication is being studied by Boeing Airplane Company under a Rome Air Development Center contract. The technique is based on the transmission of earth currents—subsurface electromagnetic waves—for communications between control points. Space Electronics Corporation is contributing under the same contract and has already done considerable experimental work in this field.

High-Frequency Transistors.—Wright Air Development Division has sponsored the development of high-frequency silicon transistors, capable of withstanding 100-ampere collector current with a power rating of 1,500 watts. A smaller 10-ampere unit, rated at 150 watts, has been operated at 10 megacycles with 109 watts' output at better than 50 per cent efficiency. The transistors were developed by Pacific Semiconductors, Inc.

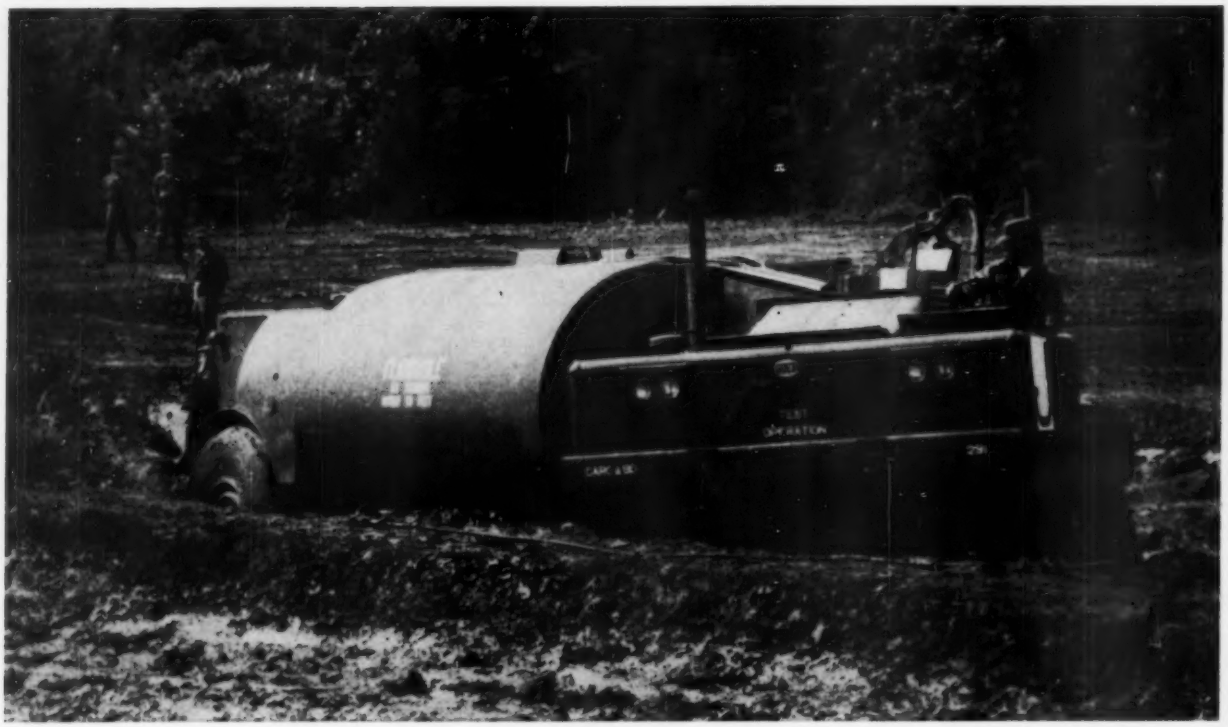
Three-Dimensional Plotter.—A new plotter, which can make three-dimensional graphs of aircraft and missile flight paths, has been developed by Chrysler Corporation. When coupled to radar and an analog computer, the plotter can almost instantly record and present a picture of a vehicle's flight path. The plotter is expected to undergo a period of testing and evaluation at White Sands Missile Test Range, N. Mex.

BMEWS.—The first Ballistic Missile Early Warning System (BMEWS) installation, located in Greenland, is expected to be operational this fall. The Greenland BMEWS site will be capable of giving SAC bombers and missiles at least fifteen minutes' warning in the advent of a ballistic-missile attack. Two more BMEWS installations, in Alaska and Britain, are scheduled for completion in 1961.

Solar Communications System.—The Air Force is backing development of an optical space communications system which will make use of the sun's radiant energy. Called a solar communications system (Socom), the device is under development by Electro-Optical Systems, Inc. Advantages of optical wave lengths are long-range transmission and security resulting from the narrow beams of optical radiation. Additional advantages, the company says, are reduced weight, lower required power, superior reliability, and the high signal-to-noise ratios possible in space.

Lieutenant Colonel Van Vliet, U.S.A.F. (Ret.), formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is an electronics systems engineer in the California Division, Lockheed Aircraft Corporation, Burbank, Calif.

The "GOERS"



Ploughs through mud. Hip-deep mud couldn't stop this 5,000-gallon tank unit.

Swimming a lake. 15-ton cargo carrier with 4-wheel drive crosses small lake.

This mark tells you a product is made of modern, dependable Steel.

that go anywhere

built stronger and 8½ tons lighter with USS "T-1" and MAN-TEN Steels

Here is a new type of off-road transport vehicle capable of delivering military supplies where conventional U. S. Army trucks couldn't go. Two GOER prototypes—a 15-ton cargo carrier and a 5,000-gallon fuel tanker, fully loaded, climbed slopes, threaded their way through boulders, scaled a 30-inch vertical wall, snaked their way through hip-deep mud, skimmed over a sand trap and topped off the performance by swimming across an inland lake.

The GOER was conceived by the Continental Army Command (CONARC) Armor Board based upon the Transportation Corps' success with large diameter tires. It was designed and built by Le Tourneau-Westinghouse, Peoria, Illinois, earthmoving equipment manufacturer, under contract with the U. S. Army Ordnance Tank-Automotive Command, Detroit Arsenal. To deliver the greatest possible loads with the least weight, extensive use was made of super-strength USS "T-1" Constructional Alloy Steel and USS MAN-TEN High Strength Steel.

In the cargo carrier, 3,500 pounds of USS "T-1" Steel, which has a minimum yield strength of 100,000 psi, were used in structural beams and members of the rear body and in the case structure of the rear assist units. About 4,000 pounds of USS MAN-TEN Steel provide strength and stiffness in the corrugated side sheets of the cargo unit. USS MAN-TEN has a minimum yield point of 50,000 psi.

The tank trailer used about 1,500 more pounds of USS "T-1" Steel, while the tractor unit was built stronger and lighter through the use of another 2,000 pounds of "T-1" Steel in the steering housing and final drive case.

17,000 pounds of weight saved. According to Le Tourneau-Westinghouse, the use of these two steels—USS "T-1" and MAN-TEN brands—saved 8½ tons of weight. The machines were tougher and stronger—hauled more load and could go practically anywhere.

Design stresses. For static design loads (one G), the builder used allowable stresses that are about the same as used in bridge design . . . 50,000 psi for USS "T-1" Steel and 27,000 psi for USS MAN-TEN Steel. For dynamic loads (three G) the maximum stresses were calculated at 90,000 psi for "T-1" Steel and at 45,000 psi for MAN-TEN Steel. These stresses approach the yield strength of the steels which is permissible for dynamic loading.

For further information on any of these Special Steels, USS "T-1," MAN-TEN, COR-TEN or TRI-TEN, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, "T-1," MAN-TEN, COR-TEN and TRI-TEN are registered trademarks

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United States Steel Supply—Steel Service Centers
United States Steel Export Company
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A

B

C

(A) Rolled steel armor can be flame-cut accurately to ½" tolerance. There is no need for sawing. Armor fabrication shown here is at **Acetogen Fabricators, Inc., Chester, Pa.** (B) Only "clean-up" grinding of rolled steel armor is needed after flame-cutting. (C) Jig-welding is easy with rolled steel armor.

New U. S. Army M-60 tank uses USS Rolled Armor for hull bottom plates and numerous cover plates and access hatches. (U. S. Army photograph)

USS Rolled Steel Armor Plate is economical and easier to fabricate

Pound for pound it gives more all-around protection than any other metal

USS Rolled Steel Armor Plate offers a combination of hardness, toughness and soundness that assures maximum all-around protection against ballistic attack. What's more, it can be fabricated readily and is economical to use. For these reasons, it has been widely adopted for tanks, personnel vehicles, and all kinds of naval and amphibious craft. In the new U. S. Army M-60 main battle tank, for instance, USS Rolled Steel Armor is used for the hull bottom plates and numerous other critical parts in conjunction with cast steel armor.

Initial cost and ease of fabrication lower total cost.

1. The cost per pound of rolled steel armor is considerably less than that of other materials, yet it provides highest strength with minimum bulk.
2. Rolled steel armor can be flame-cut to $\frac{1}{32}$" tolerance and is easier to fabricate than materials which have to be sawed and machined.
3. Grinding is needed only to clean the edges.
4. Only ordinary arc-welding equipment is needed to weld rolled steel armor either in the shop or in the field.

If ballistic protection, lightweight design and economy in materials and fabrication are important to you, get in touch with our armor plate metallurgists who are ready to discuss in full detail the advantages of rolled steel armor plate. Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company
United States Steel

This mark tells you a product is made of modern, dependable Steel.

MISSILES AND GROUND SUPPORT

Alfred J. Zaehringer

President, American Rocket Company, Wyandotte, Mich.

Minuteman ICBM.—Rapid progress is the word on this solid-propellant ICBM. In May, the Air Force announced that firing successes on the Thiokol first stage had accelerated the entire program. Successful tests of the full-thrust, limited-burning-time engine had taken place from an operational-type underground silo launcher. Later, Aerojet-General Corporation successfully fired a flight-weight second-stage engine of full-scale thrust and for full duration.

Aerojet also has successfully tested a lightweight titanium third stage. The entire casing is made of titanium metal and is one-third lighter than a conventional steel casing. In June, Hercules Powder Company announced development of a lightweight plastic case for the third stage. The case is a combination of glass filament and resin giving tensile strengths of alloy steel at about the weight of magnesium.

Finally, in July, the Air Force awarded a Minuteman ICBM contract to Boeing. It involves only work connected with the hardened and dispersed concept in which the missiles will be placed in blast-resistant underground silos, ready for immediate "push-button" launching. The contract extends through December 31, 1961. A mobile system is expected to be covered under another contract. Scheduled for operational use in mid-1962, the first wing of three squadrons will be deployed in the area near Great Falls, Mont.

Antimissiles.—The fifth and last of the early test models of the Army Nike-Zeus was successfully test fired over a ballistic trajectory at White Sands Proving Ground. Both booster and sustainer are designed to push the antimissile to hypersonic speeds in seconds. The Zeus was slant-launched at a 37.5-degree angle from the horizontal to reconfirm the missile's ability to withstand the destructive air friction of the earth's dense atmosphere. Future tests of the missile will be of its tactical configuration.

Meanwhile, a massive Nike Zeus target-tracking radar was airlifted to Ascension Island in the South Atlantic. The 78-ton instrument was shipped in four sections via giant Air Force C-133 Cargomasters from Tulsa, Okla. The radar will be given environmental tests against IRBM and ICBM rockets launched from Cape Canaveral, Fla.

Future installations of the radar will be tested at White Sands Missile Range, N. Mex. and Kwajalein Island in the South Pacific. It is from Kwajalein that Nike Zeus missiles will be launched against incoming ballistic-missile targets. Information pertinent to detection of ballistic missiles will be fed to the Ballistic Missile Radiation Analysis Center.

Recently established at the University of Michigan, the center will collect and analyze data about radiation emitted by IRBM's and ICBM's as they blast off, thrust into space, and finally reenter the atmosphere.

During its flight, the ballistic missile creates radiation over nearly the entire electromagnetic spectrum. It now becomes a goal to detect these radiations and use them for defense.

Rocket Sleds.—Three propulsion methods for rocket sleds have recently been in the news. Aerojet-General has completed design of a controllable liquid-propellant rocket engine of 50,000 to 150,000 pounds' thrust. The AJ10-115 will accelerate a 3,000-pound payload to over Mach 2 and have an acceleration rate of 20 G's. Total starting weight is around nine tons, and includes the payload which may be pushed ahead in a separate sled or carried within a nose section joined to the engine's power plant.

In June, a 2½-ton monorail sled rocketed along the Air Force Missile Development Center Track at Holloman AFB, N. Mex. Three Hercules Powder Nike boosters, each developing about 50,000 pounds of thrust, pushed the 48-foot-long sled to 3.5 times the speed of sound—a velocity of 2,650 miles an hour. The sled covered 5.5 track miles in 15 seconds. Each Nike booster is 16 inches in diameter, over 10 feet long, and costs under $3,000. An impact into a pile of sand at

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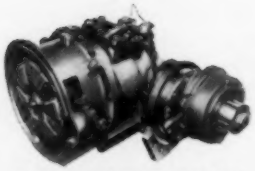

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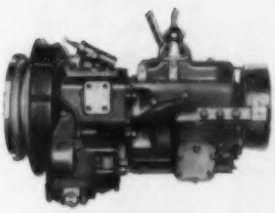

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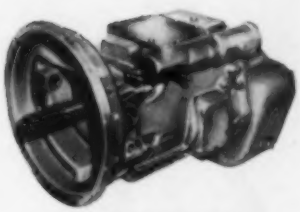

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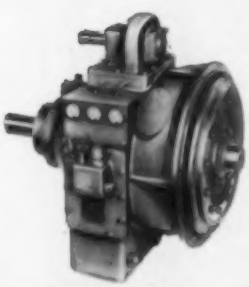

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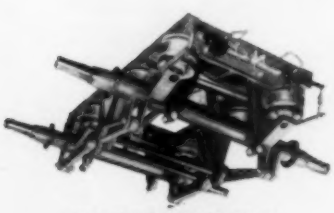

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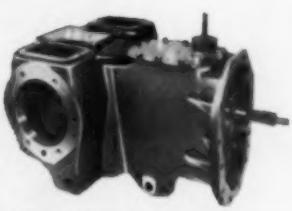

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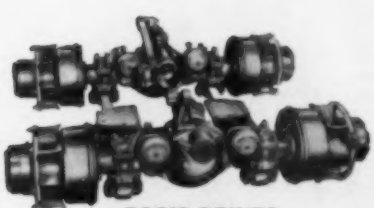

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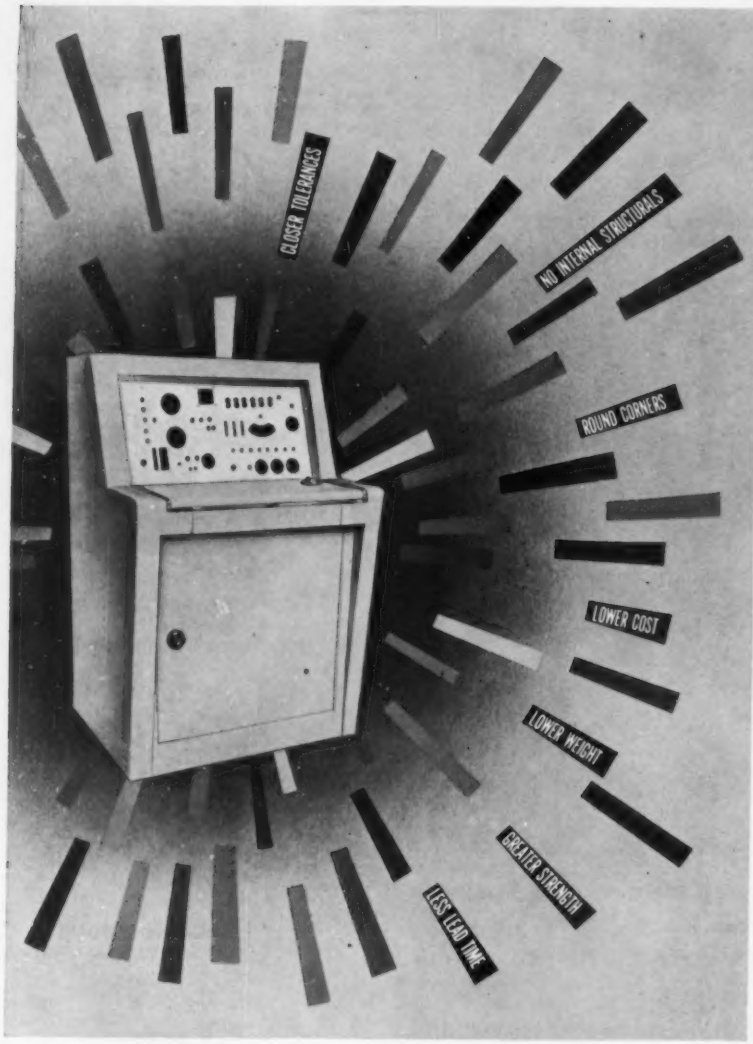

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Missiles and Support (Contd.)

the end of the run was precalculated and was a part of a missile warhead fuzing system program.

Another monorail sled at Holloman was powered by a cluster of three Grand Central Javelin rockets. This sled hit a speed of 2,688 miles an hour. A new braking method with fins opening directly into the windstream brought the sled to a halt 59.4 seconds from start—or under three-fourths of the 35,000-foot-long captive test track.

Pershing.—As of June 30th, the Army 2-stage missile had been fired successfully five times. This was the first time in the history of the Atlantic Missile Range that a new research and development missile achieved five successes on its first five flights. Moreover, the Army put the missile through a midair zig-zag under preset conditions to test the missile structure and control systems under the severe stress imposed by changes in direction.

The Army Ballistic Missile Agency, an element of the Army Ordnance Missile Command, is developing the solid-fueled Pershing as a replacement for the liquid-fueled Redstone already in the hands of troops.

Apache.—In a final shot at the White Sands Missile Range, the New Mexico State University fired an Apache rocket, delivering a 35-pound payload, to an altitude of nearly 40 miles. Initial gross weight was 223 pounds. The rocket is 104 inches long, has a diameter of 6.75 inches and sells for under $1,500 in quantity.

Liquid Hydrogen Engines.—Work on high-thrust liquid-hydrogen-fueled engines has been reported from two industrial groups. Aerojet-General Corporation reports successful firing of a pump-fed liquid hydrogen-liquid oxygen engine of approximately 200,000 pounds' thrust. Some 17 engine firings of 150,000 pounds' thrust have been conducted using a special hydrogen pump of high capacity and high pressure.

The engine is cooled by the hydrogen circulating through its hollow tube structure. Tests have consumed over a quarter of a million gallons of the cold, low-density liquid hydrogen since tests began in 1947. Meanwhile NASA is negotiating a contract with Rocketdyne for development of its J-2 engine of 200,000 pounds' thrust. Development time is estimated at three years and cost at about $44 million.

The engine is to be used on upper stages of the Saturn rocket. A cluster of two of the engines in the second stage would increase the Saturn weight-lifting capacity by nearly fifty per cent. With a cluster of four new engines in the second stage, the weight-lifting capacity would go up nearly one hundred per cent.

What's up...and where?

Philco airborne radar for ALRI extends the vision of SAGE

ALRI, the Airborne Long Range Input system of the U. S. Air Force, is the seaward extension of SAGE, the vast electronic network that warns of aircraft approaching the North American continent. Philco will develop, produce and modify the airborne height-finding radar as an ALRI team member under the system manager, Burroughs Corporation. Philco was selected for this vital work because of its long and extensive experience in the development and production of military airborne radar and its major contributions to radar technology. Here is further evidence of Philco's leadership in advanced electronics . . . for reconnaissance, communications, weapon systems, space exploration and data processing.

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BENDIX REPORTS ON ITS SUPPORT EXPERIENCE

Bendix mobile computer-tester cuts B-58 flight control system checkout time from 2 days to 90 minutes

TETERBORO, N. J. — Helping to keep U. S. weapon systems mission-ready is this Bendix computer-on-wheels. It rolls right up to the flight line where, in 90 minutes, it runs through 750 static and dynamic tests on the flight control system as installed on the USAF Convair B-58. By comparison, the previous procedure required two days' work by three men just to make *spot* static tests. This automatic equipment, although designed for the B-58, can be modified to test any other weapon system.

TETERBORO AND SOUTH BEND

Whether your support equipment needs are commercial or military—airborne or ground—you can count on *proved* Bendix experience in systems engineering and analysis, controls, aircraft and missile systems, computer functions, and field service to supply quick, efficient answers.

Bendix Support Equipment-Teterboro—brings over 40 years' such experience to the creation of *electronic* and *electromechanical* support equipment. Specific operating fields include:

BENDIX

Hydraulic and pneumatic calibration equipment, one of the many fields of checkout and support equipment designed and produced by Bendix.

Bendix test stand checks and calibrates fuel control equipment for jet engines

SOUTH BEND, IND.—Bendix fuel control test stands reproduce operating conditions such as RPM, altitude, fuel flow, temperature and pressures required for critical testing and calibration of all propulsion control systems —both systems now in use and planned for the future.

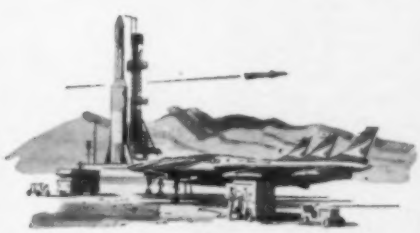
The reliability, versatility and ease of operation inherent in the Bendix test equipment springs from a position of knowledge and experience which is unique in the industry. Since the beginning of the aircraft era, Bendix has actively engaged in the design, development and production of fuel control equipment for all major engine manufacturers. Bendix test stands are now in use at military, airline and commercial installations around the world.

SUPPORT CAPABILITIES EXTEND ACROSS THE BOARD

manual and automatic checkout equipment; adaption equipment; coordinated modules of both checkout and adaption as complete systems; training devices and simulators; and monitoring equipment.

Bendix Support Equipment-South Bend—draws on its 35 years' aviation and automotive experience to produce *hydraulic, pneumatic,* and *mechanical* support equipment. Its operating areas include: silo, above ground, and shipboard launchers; transporter systems and sub-system components; missile erection equipment; handling, hoisting, jacking, and lifting equipment; test equipment and complete test facilities; and hydraulic and pneumatic power generating and supply systems.

Find out today how this vast array of *proved* systems experience can help solve your specific support problems.



SUPPORT EQUIPMENT

THE Bendix CORPORATION

TETERBORO, N. J. **SOUTH BEND, IND.**

SPACE ARMAMENT

Saturn Booster Tested

A super rocket engine designed for the massive Saturn—the Nation's first interplanetary space vehicle—has been test fired successfully by the National Aeronautics and Space Administration. Functioning perfectly, the Saturn booster generated 1.3-million pounds of thrust, four times as much as America's giant intercontinental ballistic missiles.

The giant rocket engine actually is a cluster of eight highly reliable liquid propulsion units, linked to fire simultaneously. Rated at 188,000 pounds of thrust each, the H-1 engines are produced by Rocketdyne Division of North American Aviation, Inc.

Developed by the Marshall Space Flight Center of NASA, Saturn will make possible manned flights to the moon and instrumented probes of planets deep in space. First flight of the booster and dummy upper stages is scheduled for 1961.

NASA also has selected Rocketdyne to develop a 200,000-pound-thrust liquid-hydrogen-fueled engine. Development will take about 3 years and cost some $44 million.

The engine may be used in clusters of two or four to power upper stages of advanced configurations of Saturn. The engine will be the single-start type but can be modified readily to make it capable of multiple starts in flight. The use of liquid hydrogen as a fuel in upper-stage rockets allows significant increases in payload.

The initial Saturn will be capable of boosting 25,000 pounds into a 300-mile earth orbit or sending 9,000 pounds on an interplanetary mission. Introduction of a new second-stage consisting of a cluster of 2 of the new engines would increase Saturn's weight-lifting capacity by nearly 50 per cent; with a cluster of 4 new engines in a new second stage, the weight-lifting capacity would go up nearly 100 per cent.

Largest Radio Telescope

The Jodrell Bank radio telescope located near Manchester, England, is the largest instrument of its kind in the free world. Conceived by Dr. A. C. B. Lovell and designed and constructed by the engineering firm of H. C. Hubbard, it was financed jointly by the British Government and the Nuffield Foundation. It is located in an open field of the Jodrell Bank Station near Manchester in Cheshire, England.

The huge dish has been used to track both U. S. and Soviet earth satellites and space probes, to chart radio signals giving data on cosmic explosions, to observe the aurora, and to obtain information about the planets.

The Jodrell Bank installation assists NASA under contract. It was the only tracking facility in the free world capable of tracking the 5-watt transmitter of Pioneer V beyond about ten million miles. Jodrell Bank commanded the transmitter on and off and read out its scientific information to a distance of more than 22 5 million miles.

The facility also participated in the recent transmission of radio signals between England and the United States by bouncing them off the moon.

The reflector bowl, made of welded steel plates, is 250-feet in diameter and focuses radio waves on an antenna mounted on a 62-foot tower in its center. The bowl and cradle assembly, weighing about 800 tons, are mounted on 2 steel lattice towers some 180 feet high and rotates vertically between them.

All movements of the telescope are controlled by a single operator in the main control building and are accomplished electronically. An electronic panel can amplify signals up to 30 million times. It is believed that the Jodrell telescope will be able to identify radio-wave sources one billion to two billion light years away.

Space Research Gun

A high-powered hydrogen gun that shoots meteorlike projectiles is one of the unique weapons with which scientists will launch their assault on outer space. The gun, now being built by Republic Aviation Corporation engineers, fires plastic projectiles twenty times faster than a caliber .45 bullet at different materials being evaluated for space-ship use. Slamming into the materials, they simulate the effect of meteoroids striking the skin of a vehicle in outer space. Measurement and analysis of the impact is expected to lead to better design and material choice. In addition, sequence cameras will photograph the free flight of the projectile to facilitate detailed analyses of various flight phenomena.

The gun operates when hydrogen, heated instantaneously by an electrical spark discharge to 15,000 degrees Fahrenheit in a special chamber, ruptures a metal diaphragm and forces the projectile down a shotgunlike barrel. It leaves the barrel at speeds up to about 26,000 miles an hour, finally striking the material being tested.

Ion Space Engine

The National Aeronautics and Space Administration has selected Hughes Aircraft Company to build an experimental ion engine. The development departs from conventional rocket engines in that there is no combustion. It works like this:

An alkalai metal atom (cesium) stream passes through a hot tungsten electrode which pulls an electron away from the cesium atom, creating a positively charged ion. This ion stream is accelerated and focused by several more electrodes. Finally other electrons are mixed with the ion stream so that a neutrally charged beam emerges from the engine. No nozzle is needed.

In the space of just a few inches, the ion stream develops a speed of more than 100,000 miles an hour. The small laboratory-type engine will develop only about one-hundredth of a pound of thrust. If test data prove the program feasible, later engines will be built to develop higher thrust levels.

Ultimately, scientists hope to use engines of this type to propel spacecraft on interplanetary missions after launching. They would require a nuclear auxiliary power source such as Snap-8 now under development.

Capsule Recovery Study

The Air Force has awarded a contract to the Kaman Aircraft Corporation of Bloomfield, Conn., to study the feasibility of recovering space capsules by means of a "maple seed" type of deceleration system. Helicopterlike rotary wings are proposed to slow and glide the vehicles slowly back to earth, simulating the way a maple seed spins as it "windmills" down from the tree when falling.

The study involves both the development and test of the guided recovery device and its ultimate application to space capsules, nose cones, and large rocket boosters. The first phase of the work will involve the testing of the Kaman-developed Rotochute from altitudes up to 50,000 feet. The possibility and potential of using larger Rotochutes for the recovery of heavier payloads from extremely high altitudes at supersonic and hypersonic speeds will be investigated in the second phase.

NEW ERA OF WESTERN DEFENSE

Navy launches first Polaris missile from submerged sub

Erupting from Atlantic waters off Cape Canaveral July 20, a slim white Polaris missile fired from the nuclear submarine U.S.S. George Washington launched a new era of defense. Arching skyward on a column of flame, the Polaris made its clear contribution to the security of free nations before it shook off its last drops of brine. To further demonstrate the missile's dependability, the Navy then launched a second Polaris from the nuclear sub. This was the climax of a remarkable 47-month race to develop the Navy's Fleet Ballistic Missile Weapon System. Combined for the first time were a nuclear-powered submarine, hidden in ocean depths and able to cruise anywhere, unseen for months, and a powerful missile, so compact a single sub can carry 16 of them with nuclear warheads. The Polaris gives America a defense that cannot be overwhelmed by surprise attack, a defense that will work for peace by making aggression unthinkable. Lockheed is prime contractor and missile system manager for the Polaris missile. Aerojet-General Corporation is the subcontractor responsible for the missile's rocket motor, General Electric Corporation for its guidance system, and Westinghouse Electric Corporation for the launch system. The U.S.S. George Washington was built by the Electric Boat Company.

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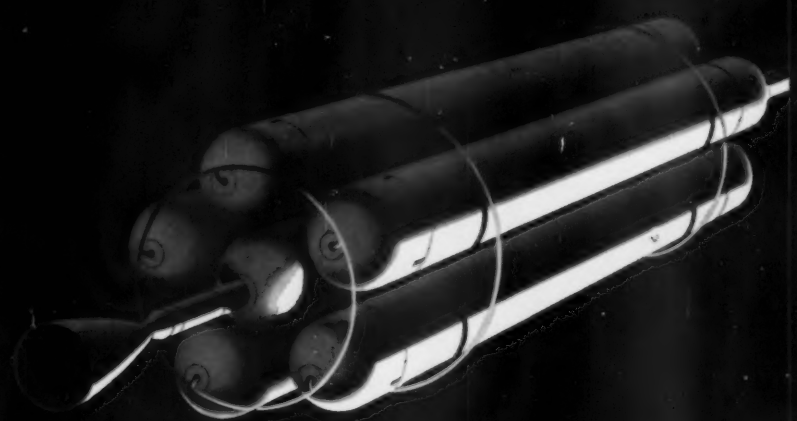
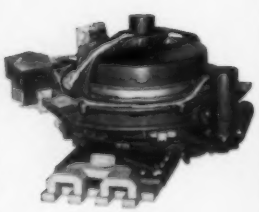
MISSILES & SPACE DIVISION, SUNNYVALE, CALIFORNIA

STAR TRACKER



SENSORS



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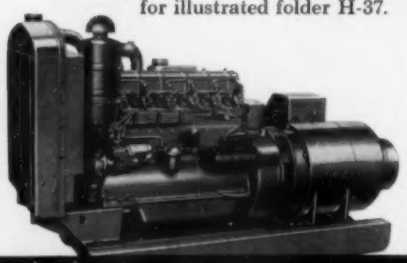

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Book REVIEWS

Reviews in this issue by:

LOREN E. BOLLINGER, *aeronautical engineer, assistant professor, Ohio State University, Columbus, Ohio.*

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

DR. JAMES B. EDSON, *senior assistant for missiles and space, Office, Assistant Chief of Staff, Army Intelligence, Washington, D. C.*

STANLEY FALK, *historian, Office, Chief of Military History, United States Army, Washington, D. C.*

MAJ. GEN. EDWARD P. MECHLING, *ordnance engineer, aircraft armament expert, Washington, D. C.*

Waterloo. By John Naylor. New York: Macmillan Company. 208 pp. $4.50.

SO many books and articles have been published on the Battle of Waterloo that a new work at this time would seem useless unless it could furnish some additional information. But the author has succeeded in producing an intriguing volume by reviewing the aspects of the famous "Hundred Days" to show that the attempt of Bonaparte to regain power was doomed from the start.

Napoleon left France bled white and prostrate when he was exiled to Elba. When he returned, conscription was impossible, and the muskets that could be made quickly were atrociously poor. As the author shows, Napoleon's army at Waterloo bore only a superficial resemblance to his former armies. His top general, Ney, was worn out and made blunder after blunder.

In commenting on another general after Austerlitz, Napoleon had said: "Ordener is worn out. One has but a short time for war. I am good for another six years, and then I shall have to stop." Exactly six years later he began the Russian campaign, and that was the beginning of his end.

At Waterloo he had no new tricks, and his new army was no longer adequate for his old bloody, sledge-hammer tactics. If the battle had been fought six years earlier, it is likely that Wellington, with his slow wit and love of ease, might have found a lesser place in history.—GEORGE S. BRADY.

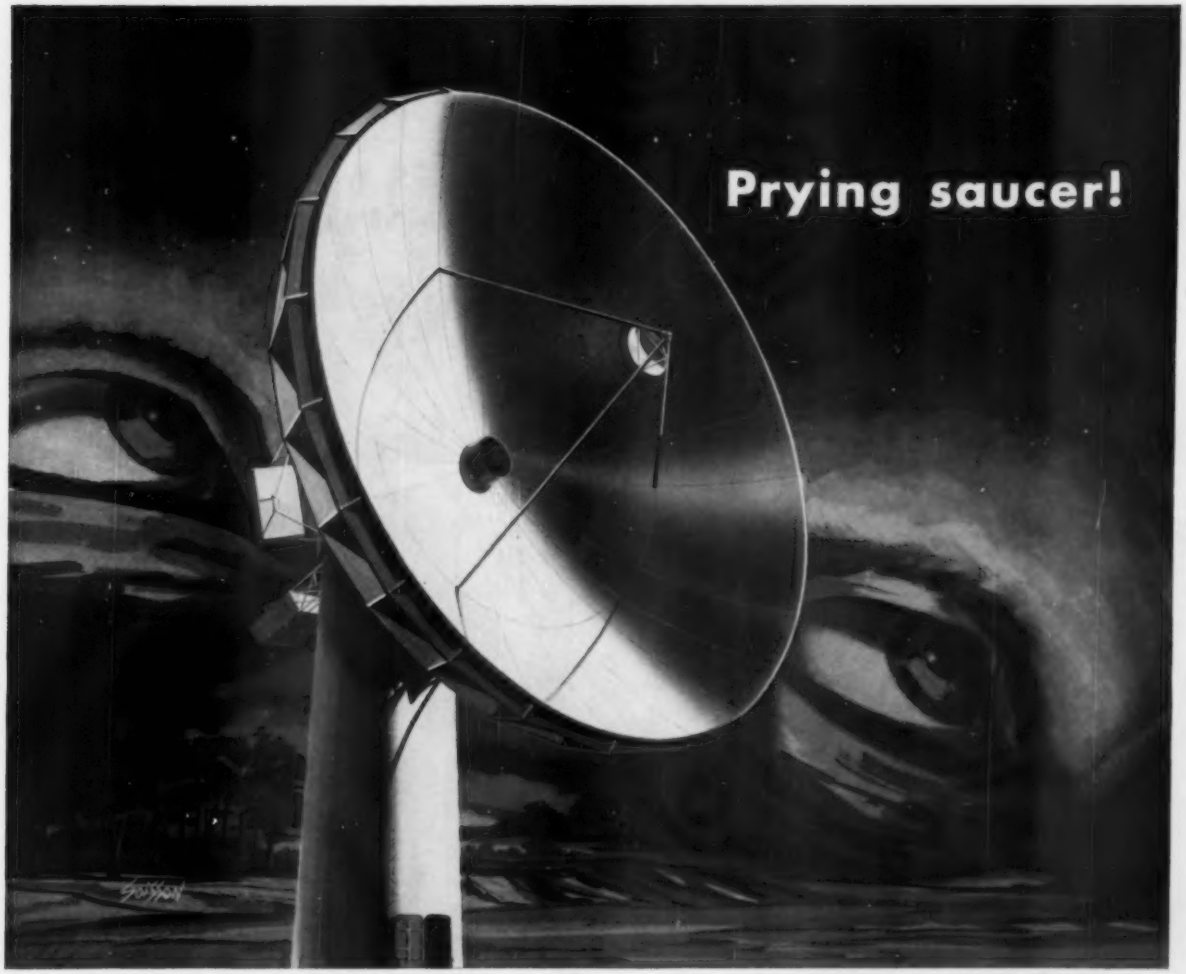
Nuclear Flight. Edited by Lieut. Col. Kenneth F. Gantz. New York: Duell, Sloan & Pearce. 216 pp. $4.

THIS book is, in style and illustrations, like a series of Pentagon briefings. Smoothly, pleasantly, and without effort the reader achieves the feeling that he understands the program. Each chapter is a discussion of a major technical area by a competent specialist of the Air Force Nuclear Propulsion Project staff.

Necessary conceptual background, nature of key problem areas, status of development, and outlook for future progress are presented for each area. Treatments of various types of propulsive and auxiliary power plants for air and space craft, of ground handling equipment, and of human factors are included. There is a chapter on "public hazards from nuclear aircraft."

The aircraft nuclear propulsion (ANP) program has been

(*Continued on p. 272*)



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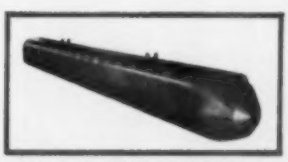
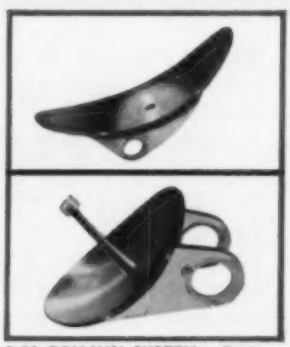


APS-94 ANTENNA SYSTEM included complete design of antenna for airborne side-looking radar.



B-58 BOM-NAV SYSTEM reflectors feature curvature tolerances of ±.005".

HEDGEHOPPING AT MACH 1
Lockheed radar shows pilot how to miss what he can't see

When a pilot hugs the deck traveling a mile *every four seconds*, his route is the world's most dangerous obstacle course. Hills, bridges and other hazards can be in his lap before he has time to maneuver safely over them. He needs information well in advance, particularly in poor visibility or at night.

And now he gets it—from Lockheed Electronics terrain avoidance radar. A compact display shows him obstacles, his position in relation to them, and the maneuvers necessary to avoid them—in time.

Lockheed Electronics systems engineers have created in one group of modules the most versatile airborne radar in flight test today. Equally effective as a mapping, bombing or navigational radar, this lightweight, transistorized unit is typical of the sophisticated equipments developed by Lockheed Electronics to help strengthen the nation's defense.

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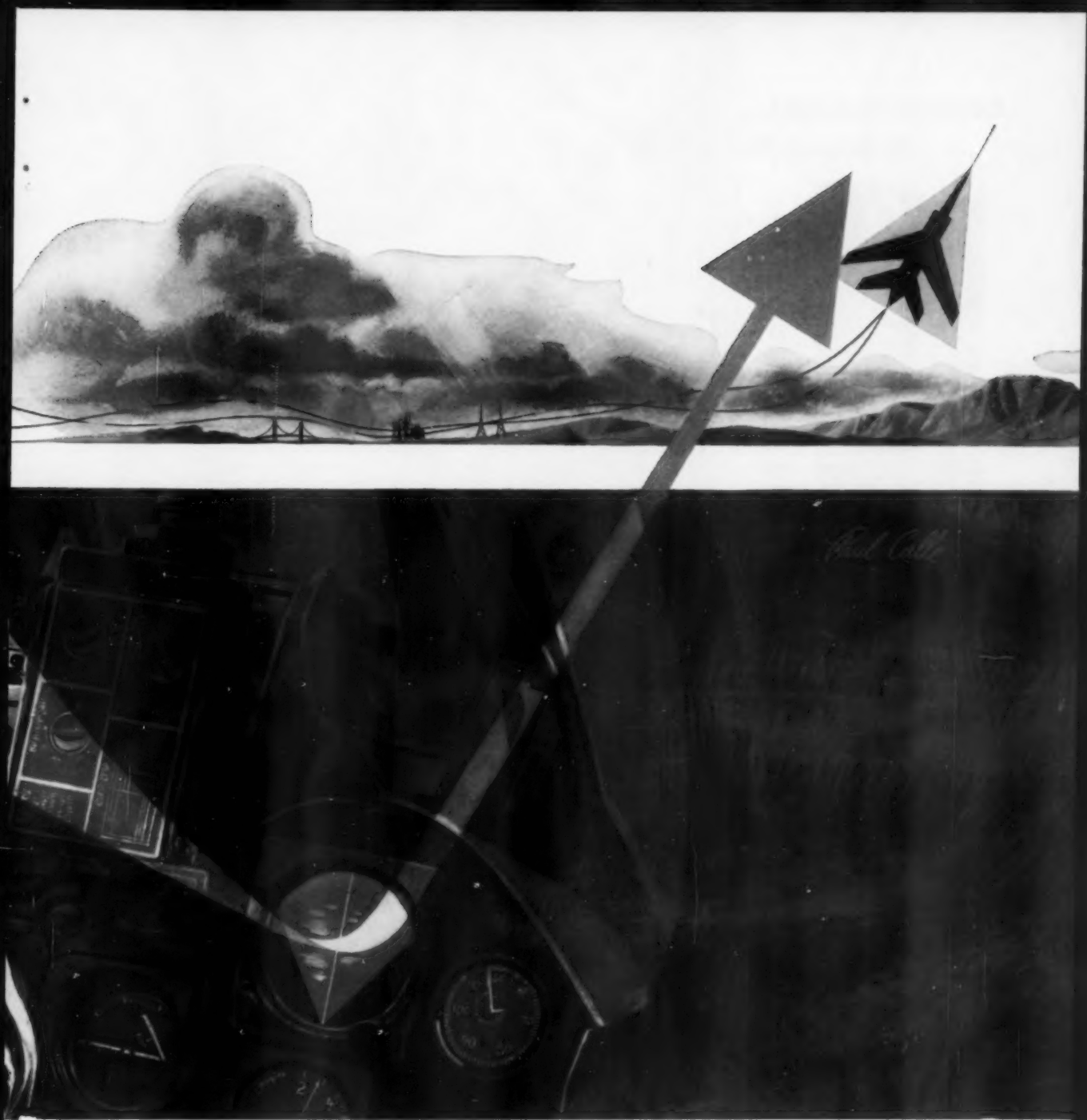

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Book Reviews (Contd.)

something of a "sleeper" in the last few years as far as public attention is concerned. Indeed, the most recent public notice has been focused on a modest by-product, the little "Snap" power source for space satellites. Events could in the next couple of years bring ANP into the spotlight. The alert Ordnanceman may well desire to "attend" this interesting Air Force presentation.—JAMES B. EDSON.

The Life and Death of the Luftwaffe. By Werner Baumbach. New York: Coward-McCann, Inc. 224 pp. $3.95.

THIS excellent book by the German General of Bombers of World War II was published in German in 1949 and now appears in English translation. The author recreates the atmosphere of the prewar and wartime life and feelings of the Luftwaffe by copious use of personal and official correspondence and by his own candid observations.

The reviewer, as one who participated in the air war against the Luftwaffe, can testify that good use was made in combat by the German resources available. Continuing shortages of important raw materials, the lack of adequate planning for a long war, and a number of strategic mistakes in the German war effort enabled the Allies to overpower the Luftwaffe and reduce it to comparative impotency by the time of the Normandy invasions.

The creation of an adequate German long-range bomber force to support the submarine effort probably would have denied the use of the United Kingdom as a base for the European invasion. Long-range escort fighters in greater numbers would have permitted increased effectiveness in the aerial Battle of Britain. The decision to continue production of essentially prewar models until it was too late hastened the decline of the Luftwaffe, and the decision to use the ME-262 jets as a bomber force rather than as defensive fighters allowed the Allied bombers to inflict mortal damage on German war production. The decision to base the German air defenses primarily on flak rather than on adequate numbers of defensive fighters was apparently only one of Hitler's many mistakes.—EDWARD P. MECHLING.

Army Exploration in the American West, 1803-1863. By William H. Goetzmann. New Haven: Yale University Press. 509 pp. $6.50.

THE role of the Topographical Engineers in exploring and opening the American West is the theme of this fascinating volume. The book's heroes are Army officers such as the glamourous and flamboyant John C. Fremont, first leader of the "great reconnaissance"; William H. "Bold" Emory, who resembled nothing more than a rough frontier cavalryman yet left his mark as scientist and explorer; James H. Simpson, whose study of New Mexican Indian civilizations was a major anthropological contribution; and Gouverneur Kemble Warren, a fighting geographer as skilled at mapping and exploring as he was at closing with a determined foe.

In the generation before the Civil War the Topographical Engineers were instrumental in providing the Army and the Nation as a whole with scientific knowledge of the American West. They made their contribution in road and railway surveys, geological and geographic studies, and botanical expeditions; in mineralogy, zoology, and paleontology; in tracing international boundaries, surveying harbors, and mapping watercourses; and by blending their military and scientific skills to provide a detailed and ordered knowledge of the American continent.

Dr. Goetzmann, who teaches at Yale, has done a remarkable job in telling this story. He has uncovered many untouched sources and has traveled extensively throughout the area about which he writes. His book is good American history, good Western history, and good military history.—STANLEY L. FALK.

(*Continued on p. 276*)

He took the luck out of heads or tails

This AMF engineer had a delicate problem: to accomplish the separation of the expended stages of a multi-stage rocket. If separation occurs too soon, thrust in the nearly burned out stage may exceed the aerodynamic drag, the tail overtakes the head, and... boom. A million dollar collision and no insurance.

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BID ASSISTANCE. As another customer service, Kaiser Aluminum offers skilled assistance in bidding defense business. Through our field offices, we offer you information on current bidding and bid results on many projects.

In addition, we can help you prepare defense bids by defining and describing items to be bid, by assisting with material take offs, and by recommending aluminum alloys and production methods best suited to a profitable bid.

TECHNICAL ASSISTANCE. Our experienced aluminum designers and product engineers are available to work with your engineers on any problem concerning aluminum design and fabrication. Often, their specialized knowledge of aluminum can be effective in arriving at an efficient and economical design solution.

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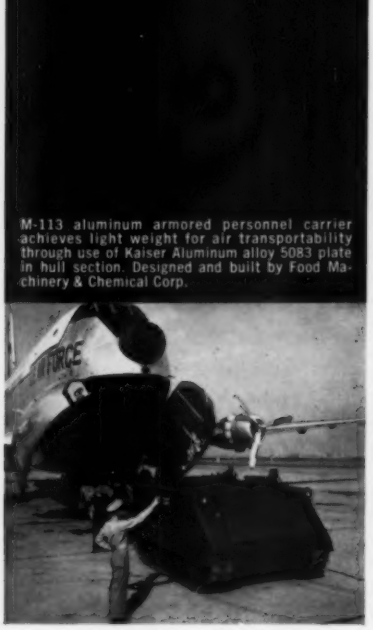
METALLURGICAL ASSISTANCE. Kaiser Aluminum operates a complete metallurgical research establishment at Spokane, Washington, and maintains specialized research facilities in California, Louisiana, Illinois and Rhode Island.

Our Department of Metallurgical Research conducts continuous research and testing resulting in new alloys, improved joining techniques and applications of particular value to the defense industry. For example, this Department has been instrumental in the development of alloys suitable for armor plate, and has conducted extensive armor research at its ballistic firing range at Spokane.

The Department of Metallurgical Research can help you solve a wide range of aluminum application and metallurgical problems.

U.S.S. Dewey, one of the Navy's newest missile-firing frigates, has a lightweight all aluminum superstructure constructed of welded, high magnesium aluminum alloys. Weight is cut two-thirds —over a 1,200,000 pound reduction. Built by Bath Iron Works, Bath, Maine.



M-113 aluminum armored personnel carrier achieves light weight for air transportability through use of Kaiser Aluminum alloy 5083 plate in hull section. Designed and built by Food Machinery & Chemical Corp.

Use of aluminum in M-60 tank contributes to greater cruising range and increased mobility. M-60 weighs 51 tons—3,000 lbs. less than M-48 model. Road wheel hubs are Kaiser Aluminum forgings. Other aluminum parts: fuel tanks, fenders, turret platform floor and road wheel discs. Designed and built by Chrysler Corporation under direction of U. S. Army Ordnance Tank-Automotive Command, Detroit, Michigan.

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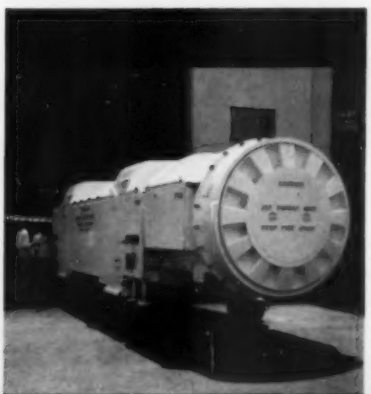
Other manufacturing facilities include sheet and plate mills at Trentwood, Washington; forging facilities at Erie, Pa.; matched 8,000-ton extrusion presses at Halethorpe, Maryland; and a complete rod, bar and wire mill at Newark, Ohio.

The new T-196-E1, self-propelled 155-mm. howitzer, has aluminum armor plate, wheels and other components. The T-196-E1 weighs approximately 46,000 lbs. as opposed to 64,000 lbs. for the M-44 which it replaces. Designed by Ordnance Tank-Automotive Command. Vehicle engineering agency is Cadillac Cleveland Ordnance Plant, GMC.

WE'RE IN BUSINESS TO SERVE YOU. All of the services and facilities mentioned here are at your disposal right now. Why not take advantage of our broad range of sales and technical experience today? Your phone call or letter will receive our immediate attention. Contact your local Kaiser Aluminum sales office listed in the classified pages of your phone book, or write: *Kaiser Aluminum & Chemical Sales, Inc., Kaiser Center, 300 Lakeside Drive, Oakland 12, California.*



Specially designed reusable Polaris missile container employs use of welded Kaiser Aluminum alloys 6061 and 5083. Container has shock absorber system and special environmental controls for proper missile transit, handling and storage. Designed and built by Lockheed, Sunnyvale, Calif.

FREE PORTFOLIO! *"Aluminum in the Defense Industry"* is a file folder full of information on the many uses of aluminum for military applications. It includes facts about the characteristics and properties of aluminum, important findings regarding welding alloys 5083 and 5086 as used in missiles, ground support equipment, cryogenics and other military applications, plus booklets covering Kaiser Aluminum mill products availabilities and designing with aluminum. For your free portfolio—mail the coupon now!

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Book Reviews (Contd.)

Fundamentals of Gas Dynamics. Edited by H. W. Emmons. Princeton: Princeton University Press. 749 pp. $20.

THIS book is one of a series published under the general title of "High-Speed Aerodynamics and Jet Propulsion." A thorough treatment is given in this volume to those aspects of gas dynamics that are extremely vital to the aeronautical engineers concerned with problems of combustion and flight in the atmosphere and in near space.

Men such as Tsien, Crocco, Kantrowitz, Von Karman, and others have written outstanding sections. The first portion contains the development of the necessary equations and a one-dimensional treatment of steady-state and nonsteady gas dynamics. Next comes the basic theory of gas-dynamic discontinuities and shock-wave interactions.

Gas dynamics of combustion and detonation together with flow discontinuities associated with combustion are covered very well. Sections that follow are concerned with the flow of rarefied gases. Slip flow and free molecule flow are covered, together with the experimental results obtained in the slip-flow and transition regimes.

The various volumes of the series are not for the extreme novice in the field. Engineers and scientists engaged in the serious study of gas dynamics, both theoretical and experimental, will find that "Fundamentals of Gas Dynamics" will make a most valuable addition to their bookshelves.—LOREN E. BOLLINGER.

The Compact History of the United States Marine Corps. By Lieut. Col. Philip N. Pierce, U.S.M.C., and Lieut. Col. Frank O. Hough, U.S.M.C. New York: Hawthorn Books, Inc. 326 pp. $4.95.

WHEN Capt. Charles Sigsbee burst out of his cabin and started groping his way toward the bridge after the tremendous explosion on the battleship MAINE, a Marine private presented himself in the smoke-filled companionway and, clicking his heels together in a rigid salute, blurted out: "Sir, I beg to report that the captain's ship is sinking."

Just thirty years later, the Germans launched an all-out attack to break the Allied lines before the Americans could arrive in France in force. They shattered the British along the Somme, and they battered the French, driving them in disorder toward the Marne.

The 4th Marine Brigade moved up the Paris-Metz road through tangled columns of frightened refugees and exhausted French troops. A French general halted the Marine officers, explaining that a general retreat was in progress, and ordered them to withdraw their men. A Marine captain, Lloyd Williams, eyed the general in amazement. "Retreat, hell!" he exploded, "We just got here!"

These are samples of the tales in this book that illustrate the alertness, discipline, and confidence which have characterized the Marines through the 185 years of the history of the Corps. In every war and "incident" since then the Marines have commanded the respect of Congress and the American people for these qualities. This volume is not a book on tactics or strategy. It is an interesting story of a branch of our defense organization that prides itself on keeping ready to meet any emergency.—GEORGE S. BRADY.

Small Arms of the World. By W. H. B. Smith and Joseph E. Smith. Harrisburg: Stackpole Company. 711 pp. $15.

THIS standard work on military small arms of the world is now being presented in its sixth edition. The author of this basic volume through its first five editions, W. H. B. Smith, died in the spring of 1959, and this edition has been revised by Joseph E. Smith, Office of the Chief of Ordnance, United States Army.

With assistance from recognized authorities both in and out of the government service, a very creditable and well-balanced revision has been produced.

New material is based on releases by governments since the Korean war not available for the fifth revision.—EDWARD P. MECHLING.

Defense. Air Vice Marshal E. J. Kingston-McCloughry. New York: Frederick A. Praeger, Inc. 272 pp. $6.

DEFENSE policy and strategy properly conceived and applied are the keys to free-world security. The author of "Defense" reiterates this thought throughout his timely and valuable volume. He is convinced that the Russians have developed policy and strategy—as well as fully effective politico-military control over their functional forces—that place the allied free-world nations at a critical disadvantage.

The Joint and Combined Chiefs of Staff committees were effective in World War II because they were supported by Roosevelt and Churchill. They are not adequate in the nuclear age. The certain devastation of a total nuclear war has brought political leaders into a major role in determining defense policy and strategy. Effective understandings between free-world political leaders is a necessary prelude to establishing defense policy and strategy by each country.

The major role of the United States in free-world defense is recognized by the author. The parallel problem of both the U. S. and the U. K. in establishing balanced forces in an economical manner, because of traditional 3-service separate interests, is reviewed. The necessity for policy and strategy on a national level rather than on the service level is clearly stated.

The responsibility for making initial decisions in both total-war and small-war situations is discussed. The interservice and interallied command-control organization is shown to be the key to effective action in any type of war situation.

The author urges the early completion of the reorganization of the U. K. defense ministry and field commands along the lines of the U. S. Department of Defense—with joint-staff and unified commands. This excellent book by a distinguished British officer is highly recommended to all who are interested in the big picture of free-world defense.—EDWARD P. MECHLING.

BOOKS RECEIVED

Aerospace Dictionary. By Frank Gaynor. New York: Philosophical Library, Inc. 260 pp. $6.

Basic Carrier Telephony. By David Talley. New York: John F. Rider Publisher, Inc. 176 pp. $4.25.

Basics of Gyroscopes. Vols. I and II. By Carl Machover. New York: John F. Rider Publisher, Inc. 112 and 120 pp. $3.30 each.

Civil Air Regulations for Mechanics. Compiled by publisher. Los Angeles: Aero Publishers, Inc. 152 pp. $4.50.

Controlled Rectifier Manual. First edition. Edited by Semiconductor Products Department, General Electric Company. New York and Liverpool: General Electric Company. 255 pp. NP.

Fundamentals of Rocket Propulsion. By Raymond E. Wiech, Jr., and Robert F. Strauss. New York: Reinhold Publishing Corporation. 135 pp. $5.50.

Fundamentals of Transistor Physics. By Irving Gottlieb. New York: John F. Rider Publisher, Inc. 152 pp. $3.90.

International Symposium on Stress Wave Propagation in Materials. Edited by Norman Davids. New York: Interscience Publishers. 337 pp. $10.

Radio Control for Model Builders. By William Winter. New York: John F. Rider Publisher, Inc. 228 pp. $4.25.

Reactor Handbook (second edition). Vol. I, Materials. Edited by D. R. Tipton, Jr. New York: Interscience Publishers. 1,207 pp. $36.50.

Treatise on Gyrostatics and Rotational Motion. By Andrew Gray. New York: Dover Publications, Inc. 530 pp. $2.75.

Zener Diode Handbook. El Segundo, Calif.: International Rectifier Corporation. 100 pp. $2.

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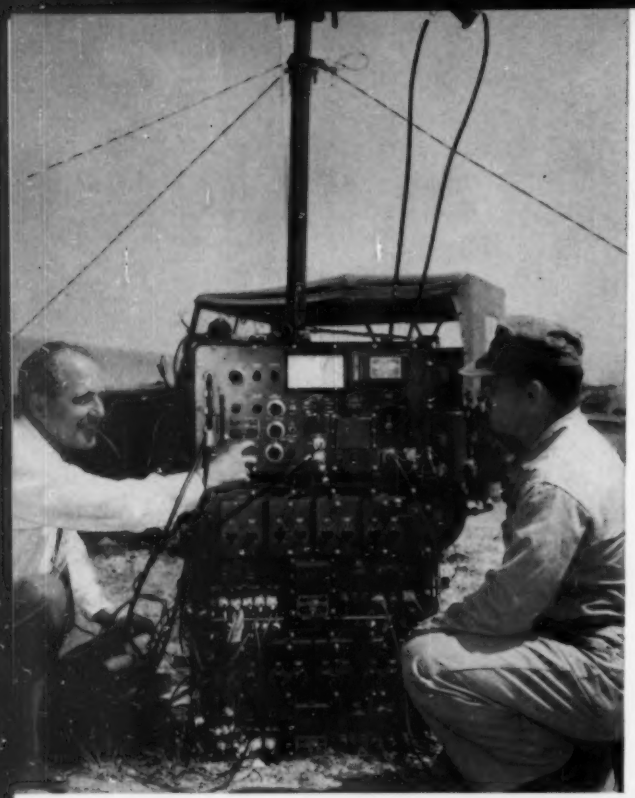
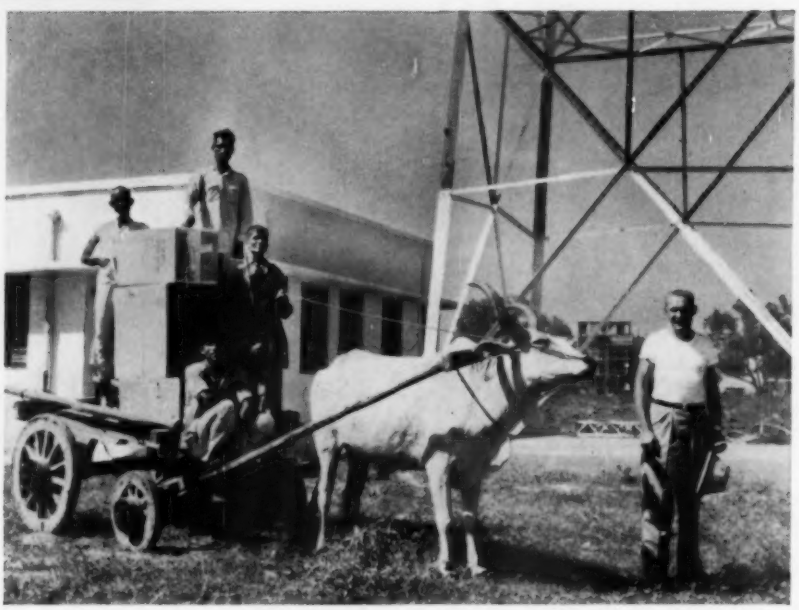


Instructing Marine Corps personnel in portable microwave communications equipment, AN/TRC-27.

In Germany, checking a proposed radar site for masking objects, preparatory to installation.



Delivering AN/CPS-9 weather radar parts for the Department of Meteorology, New Delhi, India.

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On-the-spot training in the field on part of the Hawk missile system.

(U.S. Navy photo)

About to board a B-47, this Raytheon field engineer provides technical assistance on electronic countermeasures equipment.

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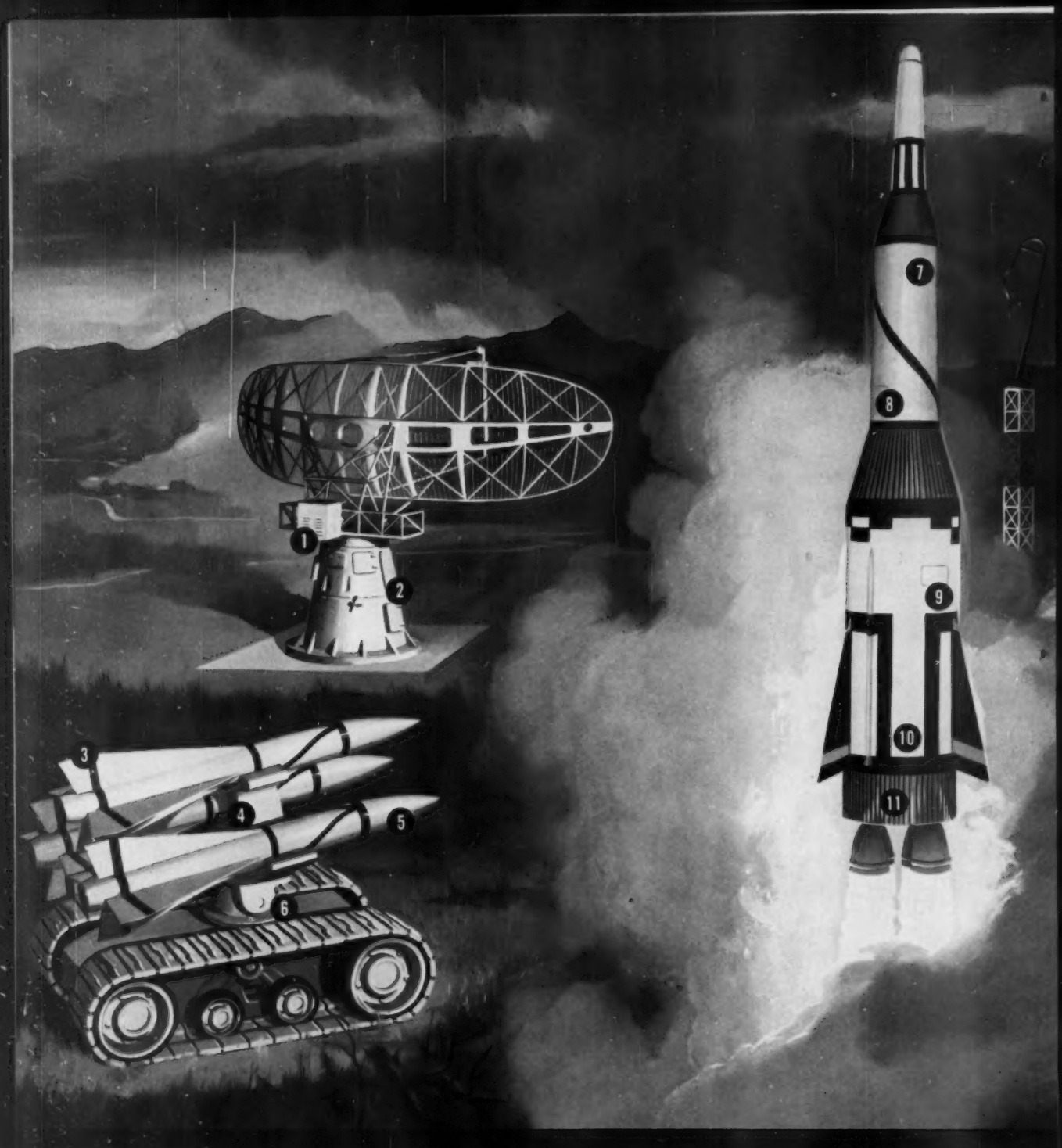

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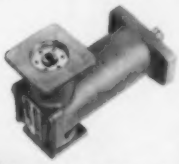

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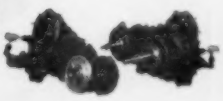

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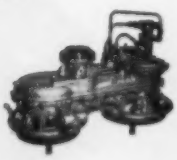

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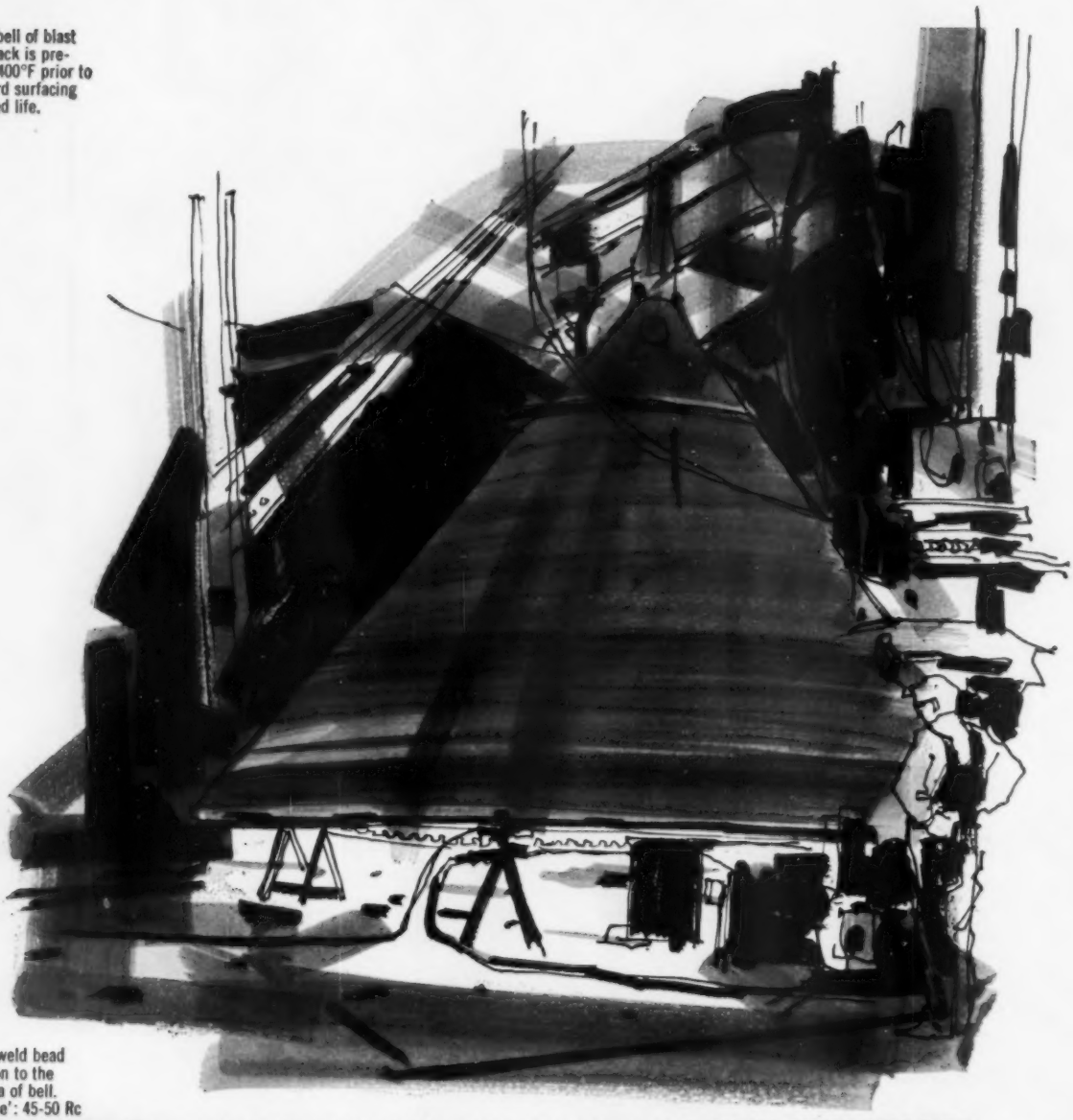

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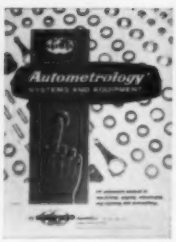
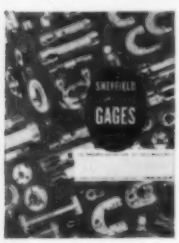


Automatic Gaging and Assembly
Review of Sheffield's building-block concept of automatic gaging and assembly machines — basic components, examples. 12-pp. Catalog AU-57-12.



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Armament Technology

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Our New Missile Strength

More Air Force intercontinental weapons are becoming operational

Col. W. D. Alexander, U.S.A.F.

Assistant Deputy Commander for Facilities, Air Force Ballistic Missile Division, Air Research and Development Command, Inglewood, Calif.

TIME is a priceless commodity, and even as enterprising Americans we have never been able to figure out how to *make* time or *buy* time. So we have done the next best thing—we have attempted to afford ourselves an added measure of time—productive, useful daylight time—by adjusting our working schedules each summer to a contrived modification of the traditional timetable.

We have done much the same thing at the Air Force Ballistic Missile Division. In the past six years, since it became clearly evident that the accelerated development of ballistic-missile weapon systems was dictated by the demands of time and circumstance, we have been working to "beat the clock" in the research, test, production, and deployment of ballistic missiles. We have recognized, too, that saving time is of little consequence unless that time is used to good advantage.

WE are prone to dwell too much on Soviet achievements of the past few years. To be sure, their activities and their intentions must be of serious concern to us, but we should not—through any forced or implied comparison—overlook the tremendous strides and the remarkable accomplishments made in the United States in the past half decade.

For in that brief period we have developed new weapons for a new age, and in so doing we have fashioned both a broader foundation for deterrent strength and a formidable base for space operations. We have been able to do this because of three things: *enlightened vision, unmatched resources, and unflagging determination*—attributes which America possesses in abundance.

SIX years ago we had frighteningly little in the way of ballistic missiles or facilities. Today we have Thor intermediate-range ballistic missiles operationally deployed in the United Kingdom. We have Atlas intercontinental ballistic missiles operational at Vandenberg Air Force Base, Calif., and another Atlas squadron on alert at Warren Air Force Base, Wyo. Our second ICBM, the Titan, is progressing most satisfactorily in its flight-test program, and our advanced solid-propellant ICBM, the Minuteman, is ready to graduate from preliminary limited-flight silo-launching tests at Edwards Air Force Base into full-scale tests from Cape Canaveral.

The reliability and versatility of our ballistic missiles, particularly the Thor, have made the majority of United States space exploits possible. This reliability is well demonstrated by

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Massive concrete doors open above underground storage and firing silo for ICBM.

the fact that forty-one of the forty-nine Thors launched during 1959 performed perfectly. The versatility of this bird also has been indicated graphically in our major space achievements. During a recent 32-day period the Thor propelled three significant payloads—Pioneer V, Tiros 1, and Transit 1-B—into space.

The Atlas has been flight-tested, both from the Cape and from Vandenberg, with gratifying success. We have achieved a degree of accuracy that could be called "sharpshooting." And the growing reliability of this ICBM is illustrated by the 1959 record of nineteen successes out of twenty-three launches.

A period of temporary disappointment in the testing of the 2-stage Titan ICBM has been more than offset by a record of 11 successful flights out of 13 launches. We have flown the Titan across 5,000-mile ranges with exceptional accuracy. Further, we have successfully demonstrated—not once, but several times—ignition at altitude of the second-stage 80,000-pound-thrust rocket engine.

FULLY as remarkable as these results that have been bred from talents and technologies are other tangible products which—though they never become airborne—are very much an integral part of ballistic missile systems.

These products are the extensive ground-support equipment, the launching sites, and the wide variety of facilities necessary to the effective deployment, maintenance, and operation of our educated rockets.

A straight line is still the shortest distance between two points. But today, with ballistic-missile velocities, the trajectory described by these missiles is the *fastest* distance between two surface points. Air Force ballistic missiles, designed to quit the atmosphere at fantastic speeds, to travel most of their distances through the thin air of space, *must begin at ground level*. In fact, certain of our Titan and Minuteman ICBM's will begin their journeys from *below* ground level.

In spite of all the interest accorded the ballistic-missile programs in recent years, there is a salient fact little realized or appreciated; namely, that four-fifths of a ballistic-missile weapon system is, like the iceberg, not readily apparent. Fully 80 per cent of the total missile system, and about 80 per cent of the cost, is vested in ground-support equipment, control and technical facilities, and personnel.

The progress to date in the construction of bases and the installation of launch facilities could not have been possible if we had not adopted and exercised the concept of concurrency in our development of ballistic-missile systems. Rather than follow the traditional step-by-step development formula such as, for example, applied to the development of new aircraft, instead we have telescoped this normal pattern and moved forward with all aspects of the program concurrently.

By taking the calculated risk—by assuming that these new weapons would conform to design theory—we have made early operational deployment not only possible but practical. We have been able to proceed with base construction work while the missiles themselves are in various stages of development and test.

By early summer 1959, we had placed under contract for construction nearly $900 million to support the production, test, training, and operational phases of the ballistic-missile program. Of this amount, approximately $115 million has been contributed by the missile contractors for expansion of production facilities as an expression of their confidence in the program; $230 million represents the Air Force investment in production equipment and test facilities; and $550 million of military construction funds have gone into test, training, and operational bases.

The Air Force share of the fiscal year 1960 Defense Department construction budget is $776 million. Of this total, approximately two-thirds will be spent on construction of ballistic-missile and space-system bases.

IT should be apparent that ballistic missiles, like airplanes, must have take-off points. To launch missiles into space, we must first move the earth—and fashioning a base of operations for a modern ballistic missile is a complex and demanding job.

A weapon's environment must be tailored to complement the characteristics and requirements of that particular weapon. The challenge implicit in this fact has never been greater than it is now. The advent of the ballistic missile weapon system has imposed on the engineering and construction professions—already noted for exceptional abilities—even greater demands for ingenuity and precision.

A ballistic missile, built to be used just once, must have maximum reliability. This insistence upon reliability extends through every element of a ballistic missile weapon system—its roots reach into the ground environment of the system itself. In the final analysis, the effectiveness of any ICBM will be traceable directly to the promptness of the people and the competency of the equipment making up this system.

It was recognized at the outset that the installations aspects of our ballistic-missile programs could not be accomplished within the allowable time span under the normal administrative organization and procedures. In order to tie

the designer of the facilities as closely as possible to the developer of the missile, it was decided that the Air Force should directly manage the design work and, in fact, be responsible through the Air Force Ballistic Missile Division for accomplishing the initial operational capability of ballistic-missile weapon systems. Various firms have been awarded contracts for architect and engineering services.

WHEN the ballistic-missile development program began in 1954 there were two companies engaged in preliminary equipment work for the Air Force according to the original Atlas concept. Since then, the expansive ballistic-missile programs have grown to embrace 25 associate contractors, more than 200 subcontractors, and thousands of suppliers. A vast Government-science-industry team makes it the biggest development program in military history.

Out of this program is emerging the "new look" of our Nation's total defense structure, as missile bases begin to take shape across the country. We have programmed for thirteen Atlas and fourteen Titan squadrons, and work is in varying stages of progress toward the completion of these facilities at the earliest possible date.

Just last April the site for the first three Minuteman squadrons, near Great Falls, Mont., was announced and construction contracts will be awarded in January 1961.

It is highly significant that although we have compressed time and expanded technology in our concurrent development of ballistic-missile weapon systems we have not been prohibited from incorporating modifications and improvements in our deployment plans. This can be illustrated by outlining the progressive nature of our Atlas and Titan implacement specifications.

At Warren AFB, and at the base near Omaha, our initial Atlas squadrons will consist of missiles positioned above ground in the horizontal configuration.

But at the second round of Atlas bases—Fairchild AFB in Washington, Forbes in Kansas, and Warren III, Wyo.—the missiles will be protected by dispersal and by hardening. By this I mean that the launching sites will be spaced a considerable distance apart, and will be sheltered in concrete and steel "bunkers" in their horizontal positions.

The word, "hard," as a measure of protection of missile-launch sites from enemy attack, is of course relative. The scale of hardness might conceivably run from "soft" for which no protection is provided to "superhard" which would indicate immediate launch capability after experiencing a direct hit by the largest feasible nuclear bomb.

Somewhere between these two extremes is a condition we shall call "hard," the value of which is based on estimates of enemy missile potential, accuracy of bomb delivery, size and number of bombs, number and dispersion of our launch complexes, cost of launch construction, degree of launch automation, and hundreds of other items.

For purposes of general discussion, hardness is usually expressed in terms of the pounds per square inch of airblast overpressure of the launch site and the energy yield of the nuclear device in kilotons or megatons. Thus, assuming there is a surface burst of a weapon of prescribed yield, the air blast pressures will decrease with the distance from the burst to the design overpressure for the base.

THE implication is, therefore, that a base inside the circle of higher overpressures will fail and one outside will be safe. Obviously, no such demarkation exists for there will always be uncertainties in both the environment and the abilities of the base to withstand the environment.

These twin tubes will be part of an underground network of ICBM launching sites now being built.

We have carried the concept of hardening to an advanced degree with the squadron to be built at Schilling AFB, Kans., and in all Atlas units beyond. There the missiles will be inserted into underground silos for full protection against anything short of a close hit by a nuclear warhead. Sheltered in these 170-foot deep silos, the missiles can be fueled below ground and raised by elevator to the surface for immediate launch.

In recent weeks we have also increased the number of Atlas missiles to be assigned to these silo-configured squadrons. Under this concept, the entire ballistic missile and its attendant equipment is supported by a steel crib hung by shock mounts from the walls of the silo. The launching sequence—a sequence to be continually practiced by Strategic Air Command crews in the critical days ahead—is well established and carefully timed: First, disengage the shock mounts, load the liquid oxygen aboard the missile, open the bascule-type doors at the top of the silo, raise the missile to the surface, and launch.

HARDENING of Atlas launching facilities in this manner means that all these facilities are self-supporting (the missiles will use inertial guidance, eliminating the necessity for above-ground radio-controlled guidance equipment) and are designed to be operable *after* an enemy action.

The Atlas silo configuration actually is an improvement in ICBM deployment plans based on the underground environment originally planned for the Titan. The first six Titan squadrons are now all under construction, with the first squadron—at the base near Lowry AFB, Colo.—expected to be operational in mid-1961.

These Titan squadrons are designed in the three-by-three pattern—that is, three launching sites of three launchers each, separated by an appreciable distance but still making up an individual squadron. The three launchers are connected by a system of tunnels to a powerhouse control center and antennae for the radio guidance. Each launcher has two smaller auxiliary silos—one for the propellant loading system and one for support equipment.

Here again, the missile is supported in a steel crib and shock-mounted. The RPI fuel is stored aboard the Titan, with the LOX added once the countdown has begun. Elevators raise the missile to the surface for launching.

SOME of the statistics regarding the size and complexity of these Titan facilities are breath-taking. Each of the 9 missile silos required for one Titan operational squadron has an inside diameter of 40 feet and is deep enough to enclose a 15-story building. Each squadron requires 90,000 cubic yards of concrete, or the equivalent of 350 miles of sidewalk four feet wide, and 12,000 tons of reenforced steel equivalent to 5,000 miles of ⅝-inch diameter reenforced bar.

Some 12,000 tons of piping are installed in every squadron in addition to nearly 2 million pounds of stainless steel. There are 10,000 feet of tunnel, 570 miles of electric wiring, and three underground powerhouses each of a size sufficient to serve a city of 5,000 population. The mammoth steel doors separating the control silos from the missile silo weigh many tons apiece.

Beginning with the seventh Titan squadron we shall incorporate another improvement designed to increase even further the survivability of our missiles. With these squadrons the Titan will be launched *directly from the silo.* The fuel *and* oxidizer will be stored aboard the missile—a development made possible by a break-through in the development of storable propellants—and the missile will use all-inertial guidance. The planned deployment is on what we call the unitary system; that is, each launcher will be dispersed from the others by several miles.

"Fully 80 per cent of the total missile system, and about 80 per cent of the cost, is vested in ground-support equipment, control and technical facilities, and personnel.

"The progress to date in the construction of bases and the installation of launch facilities could not have been possible if we had not adopted and exercised the concept of concurrency in our development of ballistic missile systems.

"Rather than follow the traditional step-by-step development formula . . . we have telescoped this normal pattern and moved forward with all aspects of the program concurrently."

The first in-silo configuration is now being built at Vandenberg AFB where the feasibility of this concept will actually be tested. All Strategic Air Command crew training exercises on Atlas and Titan missiles will be conducted at Vandenberg, our familiarization and check-out base as well as the first base to boast an operational capability.

With Minuteman, to become operational during the summer of 1962, we plan to incorporate hardening, fast reaction, and mobility into our deployment concepts. Minuteman is the intercontinental ballistic missile which reverses the historical trend toward progressively more complex and more costly weapons. A "compact-size," 3-stage ICBM, it will be deployed not only in hard underground launch sites, but will be put aboard special-purpose railroad cars which can roam the Nation's rail networks. Since the solid-propellant is a built-in feature of the Minuteman, launch capability will be measured in seconds.

To date seven in-silo test launches have been conducted at Edwards AFB, using an operational-type silo and a full-size Minuteman model. We have demonstrated first-stage ignition and we are satisfied that, from a technical standpoint, all previous unknowns now have been resolved.

Minuteman promises to combine the elements of survivability—hardness, dispersal, fast reaction, and mobility—with another ingredient in our prescription for comprehensive deterrent strength. The ingredient is *numbers.* Because Minuteman is cheaper to build, to deploy, and to maintain, it is the ICBM which promises to afford our Air Force defense structure the increased deterrence-in-depth attainable through numbers.

THE significance of the clock in the extension of our defense capabilities should be stressed, for in fashioning a total military defense force second to none in the world, we have only one uncompromising objective—to sustain peace with justice. If we are successful we shall have indeed established a new kind of time—a *world savings time.*

Air Force Procurement

One of the principal aims of the Air Force-Industry team is to see that weapons systems are produced in the shortest possible time, with the most defense for the fewest taxpayers' dollars

Brig. Gen. W. R. Graalman, U.S.A.F.

THE Air Force has recognized since its inception that it is a full-fledged partner with industry. Without industry the Air Force would die and could not maintain any kind of a defense posture. On the other side of this spectrum, the Air Force has something to contribute in that it spends with industry in excess of $10,000,000,000 a year through its Matériel Command.

The Air Force is unique in its procurement function compared with the other services in that its sole procuring authority is the Air Matériel Command. The Army has its technical services, all of which have procurement authority, and the Navy has its bureaus; but the only delegation for Air Force procurement is to the Air Matériel Command, and everything that the Air Force buys is done under the control, cognizance, and responsibility of this Command.

THE Air Force has recognized for a long time that its logistic function has the primary mission of supporting our combat units and our combat commands. This is the sole mission of our supply, maintenance, and transportation organizations. It is the primary mission of the procurement organization. But the procurement organization is unique in that it has to serve two masters. It not only has the mission of supporting the Air Force in its endeavors but also responsibility to the taxpayers for the expenditure of their funds.

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In this category we derive our direction through Federal statutes, and these statutes are then interpreted by Armed Services Procurement Regulations and are consistently "massaged" by the Congress.

It is between the objectives of doing the job according to the books and supporting our combat commands that the procurement man finds himself. He walks a pretty tight, thin line between these objectives, which sometimes are not compatible. If the pressure is exerted on the one hand because of certain competitive endeavors, then perhaps he is inclined to lean away from that which his good judgment might dictate is best for the mission.

Conversely, if the pressure comes from the combat command for a certain item of equipment that is wanted immediately, he may lean away from what might be called a good buy in so far as the taxpayer's dollar is concerned. If you don't like being in the middle, you shouldn't be in procurement.

But within this framework, according to statute, there is only one way that the Government buys—and that is by normal advertising. Essentially this means a completely inflexible buy at the low price without benefit of judgment. However, the framers of the law, in their wisdom, recognized that there were things you couldn't formally advertise, and, like the hearsay rule in law, it, too, has exceptions. And it's within these exceptions that we in procurement do negotiation.

THERE seems to be a popular opinion—perhaps even among some of our legislators, that advertising is the only competitive buy that the services make and that negotiation is an under-the-table sole-source operation. Nothing could be farther from the truth. As a matter of fact, those things that we buy "sole source" are the very rare exceptions in this great land of free enterprise that we have today. Even a weapon system for which we must negotiate is bought by competition.

Any time we have a requirement for a new item, whether it be a missile or an aircraft or any of the other types of systems, communications and otherwise, we open it to competition. At this point in time the Air Force doesn't know exactly what it wants. We think we know what we don't want. So those people who are interested, or who feel that they have a capability, and all those that we feel might have a capability, are solicited for proposals.

We ask for proposals as to design; the manner in which the development will be achieved; the parameters of the performance characteristics; some idea of what kind of a schedule can be

achieved; and an estimate of what it will cost. All these proposals as they come in (and they're pretty expensive to prepare, we realize) are then given to a selection board.

This board is composed of various senior officers and civilians of the Air Force who are experts in all the various fields of engineering, pricing, contracting, scheduling, production, or what have you. Out of this emerges their recommendation for a winner of the competition. Thereafter the Secretary of the Air Force makes the selection, and this bidder is the winner. This is the company, then, with which we negotiate a contract.

USUALLY these contracts are in phases. In the climate that we have today with technological breakthroughs and with the absolute mandate that we must move faster and farther into the realm of the unknown, our initial contract effort is usually just that—an effort—a phasing, a parameter, so that we can more clearly determine what it is we really want.

Thereafter, we get into the matériel stage. We must then, necessarily, go back to the supplier. This is done through an Exception Nr. 14 of Public Law 413. The reason we must do this is because there is nobody at that point who can possibly achieve the time schedule, who can establish the tooling, or who can match the development know-how.

How do we contract for these items? Obviously the normal, nice way to contract is through an Invitation for Bid (IFB), getting quotes from a number of competitors, and letting the competition in itself determine a right price. But most of these types of buys the Air Force does not make. The Army and the Navy have been delegated as a sole-source responsibility for a lot of our off-the-shelf requirements. The General Services Administration, for instance, buys all our so-called housekeeping materials. The Navy buys all our petroleum. The Army buys all our foodstuffs, textiles, clothing, etc.

Air Force procurement is primarily the business of buying weapons systems and all those things necessary to support them. As these systems become more complex, our buying job becomes more and more difficult.

We do have tools, however, that we can utilize. We recognize that no contractor in the world could possibly make the investment for the facilities and tooling it would take to produce a major weapon system. He couldn't even handle his payroll without an assist from the Government as he goes along.

So we normally start out with what we call a cost-plus-fixed-fee contract. This is a contract in which the Government assumes the risk. We used to say *all* the risk, but industry asked us: "Haven't you heard of Section 15 of the ASPR? We have seen the listing of the unallowable costs we have incurred that you won't pay for." So maybe I should say that the risk is minimal in a cost-plus-fixed-fee contract.

In this area we try to determine between us our best appraisal of what this particular work statement will cost. Having decided on this we then establish a lump-sum dollar fee for that effort as profit to the corporation. This fee then remains constant, but the cost target does not. Irrespective of how much that cost target is overrun, the Government will pick up the tab if they are allowable costs. Conversely, if the target is underrun and we are budgeted for the target, then the taxpayer recoups all the dollars as a result of that underrun, or the reduced cost as estimated.

We don't like this type of contract very well in the Air Force because we feel that it lacks the vital ingredient of incentive. If a contractor's fee remains the same, irrespective of how much money he spends, the old monetary incentive is not there. So about five or six years ago the Air Force devised a cost-plus-fixed-fee contract with an incentive provision to try to beat the target that we have mutually agreed on as to cost.

SO we work out a sharing arrangement with the contractor. We'll say: "If this target we've agreed on is less when you get through, the savings we will share with you, and you can put those dollars in your pocket as additional profit over and above the fixed fee that we have negotiated. Conversely, if you overrun that target, we will penalize you for part of that money as against the fee that we have negotiated."

When a contractor gets a contract like this, there's a hell of a prayer meeting back at the plant. And the percentage which we will share with him is pretty much dependent upon him. How much risk does he want to bear—10, 20, or 30 per cent? It works both ways—if he wants 20 per cent of the risk, then he'll get twenty per cent of the savings. Conversely, if he goes over the target he'll bear twenty per cent of the overage.

We have utilized this idea in this very difficult procurement because our buyers will buy an additional increment every year. We finally get to where we can utilize what we call a fixed-price incentive. Here we get a better and more definite estimation of costs and define the risk parameters. Then we will establish our sharing arrangement.

In this type of contract, of course, the target fee is a little higher because the risk becomes a little greater. But, again, the contractor can assume greater and greater risks if he so desires.

HISTORICALLY, as we moved into more and more research-and-development type contracts and more and more cost-plus type contracts, the contractors were besieging us with the fact that we were not allowing a high enough rate of profit. They pointed out that these types of contracts back in the old days were just a small percentage of their over-all defense business, so they weren't too concerned. But production, as such, no longer exists. The Air Force is not buying many of anything anymore. The few items we do buy cost a lot more than the many used to cost, but most of the expense is wrapped up in development.

We were faced with the fact that this type of contract was assuming more than fifty per cent of some contractors' defense business. We conducted an exhaustive survey, and we found that, by and large, our pattern of fees for cost-plus research and development contracting was a fair and reasonable return for the risks involved, and especially for the capital invested. The contractors were all looking at the percentage of profit on gross sales, which appears very small. But the true test of earnings is the amount earned on the capital invested.

This was another reason why we felt that if the contractor wants to make more profit in his defense business we'll make it possible for him to do so. All

he has to do is earn it—we won't hand it to him.

Since we've been in this incentive-type business we have been criticized by many people who say this is a bad kind of contracting because, if the contractor underruns the target, the target was wrong; if he overruns the target, the target was still wrong, but it will accrue to the benefit of the Government.

We have found that, by and large, when we were on the straight cost-plus-fixed-fee type contracting, about ninety per cent of our contracts were overrunning their targets. Today, with the incentive approach, we are finding the converse—ninety per cent of our targets are being underrun.

DOES this mean that we are not targeting tight enough? I just can't believe it. The people who are targeting our incentive contracts today are the same contracting officers and the same buyers who were targeting our CPFF contracts five years ago. Are they any less adept at establishing a fair target? Are they any less exhaustive in their analysis? Are they now abandoning, just because of the incentive provisions, the historical facts, the industry planning report, all the tools a good buyer used to determine what a thing should cost? Of course not—if anything they should be better than they were before.

Therefore it is obvious that the incentive approach works and that for every dollar that we put back into the contractor's pocket for a stockholder we're putting five dollars of the taxpayers' money to work somewhere else. Is this bad business?

As an interesting aside, industry has embraced this incentive type of contracting. They said: "That's all we wanted to know. Give us a chance to make more money, and we'll show you how we can do it." But they are also saying, "Your boys are getting too rough in negotiating the target, and it takes a hell of an incentive to break even."

I don't know about this, but I do know that through underruns we have been able to save the taxpayers a lot of dollars.

In addition to the problem that the Air Force has in contracting with industry, and our sincere efforts to try to arrive at some mutual agreement, there is still another problem that we have tried to make known. This is in the area of subcontracting. Today, with our weapon systems approach, we find that the Air Force is no longer spending its $11,000,000,000 annually for procurement. Over fifty per cent of those dollars are not being spent by us but by our prime and first-tier subcontractors. They're doing the big buying job and not doing it very well.

> *"The Army and Navy have been delegated as sole-source responsibility for a lot of our off-the-shelf requirements . . . Air Force procurement is primarily the business of buying weapons systems and all those things necessary to support them. As these systems become more complex, our buying job becomes more and more difficult.*
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> *"We do have tools, however, that we can utilize. We recognize that no contractor in the world could possibly make the investment for the facilities and tooling it would take to produce a major weapon system . . .*
>
> *"So we normally start out with what we call a cost-plus-fixed-fee contract."*

We learn through many surveys, both within the Air Force and by some of our friends on the outside, that industry was really devoting about ninety per cent of its management efforts, its ingenuity and its production, to the in-house operation of a corporation. Less than ten per cent of the total effort went into its purchasing organization.

As a matter of fact we found that the purchasing organization was subservient to production, or engineering, or the comptroller. The purchasing agent couldn't go directly to the boss. The people he was subservient to were not interested in procurement *per se;* they were interested in delivery and quality and couldn't care less about the price.

A lot of the taxpayers' money was, and is, going down the drain because of the lack of attention to the details of purchasing and the lack of a realization that this is a tremendously important function within a corporation. It deserves the best minds that the corporation has.

We also look for schedule adherence. We look for quality, and we must have it. But we don't want to pay a price that's higher than the cost plus a reasonable profit. Industry generally didn't seem to recognize this as a very basic philosophy. We found some industries that did, but by and large the subcontracting effort, between $200,000 and $4 million, just was not getting the proper treatment. No one analyzed the costs and what they should be, and very few of our major primes went so far as to look to see what the profits were that the subcontractor earned on the former buys.

Industry today has to embrace a fiduciary relationship. If it is spending this much of the taxpayers' dollars, it has to get out of the caveat area and move into the public-trust area. Unless it does so of its own volition, Congress is liable to pass some compelling legislation.

One thing that industry must do for our country and the Defense Department is to give as much defense as possible for every dollar expended. It does not mean that the Air Force doesn't pay reasonable profits; it just means that we buy at the right price.

In conclusion, I think that the one big thing that needs to be realized continually by both Government and industry is that we are an absolute team. Neither of us can live very well without the other. What makes this realization difficult is our lack of communication. It is strange that we have satellites orbiting around the earth at this very minute, and we talk to them, but we don't talk to the fellow in the next office.

If industry has a problem with us or with any of the services it should be brought up and discussed. Neither of us may be satisfied with the results, but just getting it out on top of the table and hearing the other side's viewpoint usually makes a fellow feel that he is getting a square deal.

WE must communicate vertically and laterally all the time. If we could achieve this, I think we will have gone a long, long way toward giving ourselves a better defense—and doing it for less money, which is so very necessary in these trying times.

Aerospace Research

The mission of the Air Research and Development Command is to ensure qualitative superiority of aeronautical equipment, seek new basic knowledge, and develop improved devices and systems for air warfare

Col. Carlo Tosti

THE last half century of the world's history is one of marked growth for aircraft speeds—a pattern which is typical of many others over the same period. Beginning with the 40 miles an hour of the Wright brothers' airplane in 1903, major highlights along the way were the cracking of the sound barrier in October 1947 by Captain Yeager flying the X-1; the X-1A attaining 1,650 m.p.h. on December 12, 1953; and 2,060 m.p.h. being reached with the X-2 flown by Capt. Mel Apt on September 27, 1956.

Now in the early stages of flight test is the X-15, which is designed to fly at speeds beyond 4,000 miles an hour. On August 4, 1960, the X-15 established a new speed record of 2,150 miles an hour and on August 12th set an altitude record of 136,500 feet.

Nor is this the end of the line, since we now visualize a near-orbital manned vehicle in the Dyna-Soar with a speed of about 15,000 m.p.h.

THIS same rate of progress applies to other technical fields and to the Soviets as well as to us. As a result, we are engaged today in a technological war of time, and our capability to maintain a superior military force and a positive deterrent to nuclear attack depends upon our determination and ability to take maximum advantage of today's rapid rate of scientific progress.

This has been well stated in the Rockefeller report: "A nation can achieve a basic advantage if it is able either to develop or to produce weapons more rapidly than its opponents. One of the major weaknesses in our strategic posture has been our inordinately long lead time."

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The Soviets, too, recognize the overriding importance of time. In 1958, Marshal Blagonravov, a member of the U.S.S.R. Academy of Sciences, said, "It is easy to see that precisely the time element is the decisive factor which should be grasped in the competition with the capitalist countries in the field of technology."

Lieut. Gen. B. A. Schriever, Commander of the Air Research and Development Command, has frequently stated that the pacing factor in weapon system development no longer is the rate of advance in scientific state of the art. Instead, we now progress only as fast as our organizational, management, and administrative talent can capitalize on that scientific progress.

This thesis was stressed by the Von Neumann Committee in its report urging acceleration and reorientation of the Atlas ICBM program in 1954.

It also formed the basis of the streamlined procedures (the "Gillette Committee procedures") which were applied to the Air Force ballistic missile program in 1955 by the Office of the Secretary of Defense and by the Department of the Air Force.

In the management of the Air Research and Development Command our objective will be to apply these procedures to the over-all program.

THE mission of ARDC, as stated in Air Force Regulations, is to:

1. Attain and maintain qualitative superiority of aeronautical and allied equipment and to conduct or supervise scientific and technical studies required to accomplish the Air Force missions.

2. Seek new basic knowledge for developing improved aeronautical equipment, weapons, and techniques.

3. Develop and recommend new and improved devices and systems for conducting and supporting air warfare, including complete weapon systems, techniques, and procedures.

In other words we direct our efforts to anticipate the most effective developments to meet future Air Force mission requirements and to bring them to operational readiness as soon as possible within the technological state of the art.

If we are to accomplish this objective, two concepts must be appreciated. First, we must initiate developments based on the scientific and technical feasibility of obtaining the necessary fundamental knowledge and of developing the essential components and systems on schedule.

For example, our all-out ICBM program was initiated based on the judgment of a group of eminent scientists, headed by Dr. von Neumann, that such a system was technically feasible. None of the elements of the system existed in 1954. We had no lightweight, high-yield warhead. We had no nose cone that had reentered at Mach 24. We had no suitable guidance system. We had no suitable rocket power plant.

Though none of the major subsystems of an ICBM were in existence, the Von Neumann group and other scientists had little doubt that an ICBM, taking advantage of the thermonuclear break-through, was technically feasible and would provide an effective weapon system.

Their judgment has been more than vindicated in the Thor and Atlas which are operational today.

There can be little doubt that the majority of military space systems must be developed in this same manner if we are to compress time. It would be costly in time and would lead to early obsolescence should we follow a policy of not initiating a weapon system development program until all its subsystems are fully developed and on the shelf.

Weapon system development based on technical feasibility therefore requires that the military:

1. Conduct a vigorous research, applied-research, and component-development program.

2. Conduct constant evaluation and analysis of the above activities, aided by science and industry, to ensure timely initiation of weapon system development programs.

3. Centrally manage and control urgent weapon-system programs to ensure effective systems engineering, integration, and testing which are essential to the intricate technical interface between and among the several subsystems comprising the total weapon system.

THE second concept in compressing lead time springs from competence and confidence in implementing the first concept. This is the concept of concurrence which optimizes the developer-operator relationship. This is best explained by dissecting a weapon system.

A weapon system consists of much more than the components which are developed and tested. It also requires the industrial base for its production, the operational facilities for its operation and maintenance, the training facilities and instructors to train the operational personnel, the command and communications system for its operational control, the supply and transportation system for its support, and finally the people organized and trained to operate and maintain the weapon.

The challenge, of course, is lead time, and this varies for each element, exceeding forty months for some. It is quite obvious that total lead time is vastly increased by a sequential-series approach, in which lead times for each major program element accumulate as each successive step is taken.

In the Atlas program, however, using the concurrence approach, operational and training bases were under construction at Vandenberg Air Force Base prior to the launch of the first test missile from Cape Canaveral.

Thus a compressed timetable is made possible by the management concept of concurrence, wherein each element of the total weapon system is integrated into a single plan, program, and budget and is implemented concurrently, consistent with lead-time requirements.

As an example of concurrence at work, the Thor IRBM has been deployed in numbers in the United Kingdom only 3½ years after signing the initial contract with the Douglas Aircraft Corporation.

Lunar probe vehicle leaves the launching pad (Air Force photo).

ALTHOUGH a major portion of the Air Research and Development Command is located within the continental United States, recent years have seen its activities expand around the world. About seven years ago, the European Office of ARDC was activated at Brussels, Belgium, and has been quite effective in contracting for research with leading scientists in the friendly nations of Europe and the Near East.

Further, with entry into the ballistic-missile and space age, ARDC responsibilities and activities have truly become global. The Atlantic Missile Range under the management of the Air Force Missile Test Center of ARDC extends from Cape Canaveral to Ascension Island—a distance of about 5,500 nautical miles over the South Atlantic. Also, tracking operations for the Discoverer satellite program have required the location of tracking stations not only at Vandenberg AFB, Calif., but also in Hawaii and Alaska.

The major portion of the Command, however, is located within the continental United States. Headquarters is located at Andrews Air Force Base near Washington, D. C., and it is from here that the worldwide activities of ARDC are planned, directed, and managed.

To carry out the Air Force research and development program, four major field management organizations have been established—(1) the Air Force Ballistic Missile Division at Los Angeles, Calif., which is responsible for the development of ballistic missiles and space systems; (2) the Wright Air Development Division at Dayton, Ohio, which is responsible for the development of flight vehicles; (3) the Air Force Command and Control Development Division near Boston, Mass., which is responsible for system and in-

tersystem development of all intelligence, communications, and control electronic systems; and (4) the Air Force Research Division at Washington, D. C., which formulates and manages the Air Force program of basic research.

These major management segments of ARDC are supported by research, development, and test centers spread across the country. These are the Air Force Flight Test Center in the Mojave Desert of California; the Air Force Special Weapons Center at Albuquerque, N. Mex.; the Arnold Engineering Development Center at Tullahoma, Tenn.; the Air Proving Ground Center at Eglin Air Force Base, Fla.; the Air Force Missile Development Center at Alamogordo, N. Mex.; and the Air Force Missile Test Center at Patrick Air Force Base, Fla.

Also assigned to the Air Research and Development Command is the Armed Services Technical Information Agency located in Washington, D. C., which provides a central service for the Department of Defense for the interchange of scientific and technical information among the services and its contractors to promote progress and to prevent unnecessary duplication.

The Air Force Ballistic Missile Division is responsible for the management of ballistic-missile and space-vehicle developments. Among the projects managed by AFBMD are the Thor IRBM, the Atlas, Titan, and Minuteman ICBM's, military satellite systems like the Midas missile defense alarm system, the Samos strategic surveillance satellite, and numerous special-purpose satellites and scientific space probes developed either for the Air Force program or in support of the programs of the other services and the National Aeronautics and Space Administration.

To carry out its booster-development responsibilities, the Air Force Ballistic Missile Division has charge of the Directorate of Missile Captive Tests with its large and elaborate rocket test facilities located at Edwards AFB.

The Wright Air Development Division at Wright-Patterson Air Force Base, Dayton, Ohio, manages the development of flight vehicle systems including manned aircraft (the Dyna-Soar being the most advanced manned vehicle in development); missiles to be used with aircraft systems (like the Hound Dog and the ALBM air-launched ballistic missile); and ground-launched missiles other than ballistic types (the Bomarc, for instance).

Associated with this weapon systems development responsibility is the advancement of the state of the art and knowledge in such fields as airborne electronics, propulsion, materials, and aerospace medicine.

In short WADD is responsible for research and development of weapon systems and associated equipment and techniques to operate in the environments of both atmosphere and space.

The Air Force Command and Control Development Division located at Hanscom Field, Mass., manages the development of command and control systems necessary for data collection, processing, transfer, and display, as well as other developments necessary to permit the exercising of weapon command and executive control associated with Air Force operations. It ensures the proper integration of ground electronic detection and control systems and associated weapons, such as the integration of the SAGE system with the F-102 and the Bomarc.

This division also is responsible for developing new techniques and components to advance the state of the art in these areas and for planning for the future with respect to these critical command and control systems.

The Air Force Research Division, Washington, D. C., manages the basic research program of the Air Force, working closely with the universities and research groups of this country and with the scientists in friendly nations around the world. It is also instrumental in recommending Air Force research policy.

Besides the headquarters in Washington, other important segments are the European Office located at Brussels, Belgium, and the Aeronautical Research Laboratory located at Wright-Patterson Air Force Base.

Turning now to a quick review of the development and test centers, the *Air Force Flight Test Center* at Edwards Air Force Base in the Mojave Desert of California conducts the flight testing of the latest research, prototype, and production aircraft and aircraft components and conducts research and development related to such tests.

One of the major flight programs being carried on there is the X-15, a research aircraft designed to fly faster than 4,000 miles an hour and to reach altitudes of 50 to 100 miles.

The Flight Test Center houses four Government agencies—an important tenant being the National Aeronautics and Space Administration which has located its High-Speed Flight Test Facility there and participates with the Air Force in joint research programs like the X-15.

The Air Force Special Weapons Center at Kirtland Air Force Base, Albuquerque, N. Mex., conducts research, development, engineering, and testing in the field of nuclear energy. This includes nuclear weapons and nuclear power applications, associated phenomena and environments. In short, AFSWC is responsible for research and development of techniques and equipment to employ nuclear energy advantageously in the accomplishment of Air Force missions.

The Special Weapons Center also supports the Atomic Energy Commission in carrying out its nuclear testing program in the Pacific and in Nevada, and will participate in future nuclear testing within the atmosphere and in space, if and when such testing is resumed by our Nation.

The Arnold Engineering Development Center located at Tullahoma, Tenn., is the wind-tunnel center of ARDC and is a major aerodynamic research and test center in the national unitary wind tunnel plan.

The Air Proving Ground Center at Eglin Air Force Base, Fla., plays a vital role in assuring that conventional weapon systems and supporting equipment will effectively perform their missions when assigned to operational users. A number of important test and development tasks, therefore, are assigned to this Center.

The Air Force Missile Development Center located at Alamogordo, N. Mex., is another valuable facility for the support of aerospace research, development,

and testing. Over its highly instrumented range, which is integrated into the White Sands Proving Ground of the Army and recently has been further augmented by flight-test corridors extending 650 miles to the Wendover impact area, are tested short-range guided weapons such as the Falcon air-to-air missiles and the Mace surface-to-surface tactical missile.

Geophysical and aeromedical research are supported through the launching of space probes like the Aerobee rockets and high-altitude balloons.

The 35,000-foot high-speed captive missile test track is particularly valuable in the development and test of inertial guidance system components and establishing the limits of human endurance to acceleration and deceleration.

The Air Force Missile Test Center at Patrick AFB, Fla., operates the Atlantic Missile Range—the largest missile proving ground in the free world. Perhaps, it is the most prominent of our centers in the news today. From Cape Canaveral, this range extends over 5,000 nautical miles into the South Atlantic beyond Ascension Island.

The Center conducts long-range missile research and development flight tests and collects and evaluates flight data for the Air Force, Army, Navy, other governmental agencies and missile contractors.

The range, moreover, is a major launching site for the Nation's satellite and space programs.

THE Air Research and Development Command, therefore, with its field management divisions and centers, represents an invaluable national resource for pushing out the frontiers of knowledge and human performance essential to preserving our national security and advancing both military and peaceful objectives in space.

In terms of manpower, the Command numbers about 44,000 persons—about half of them military and the other half civilian. Of the ARDC working force, about half are technical, including scientists, engineers, laboratory aides, electronics technicians, aircraft mechanics, and other technical specialists.

The other half of the force supports the technical mission through the necessary legal, contractual, medical and other required support services. So much for the quantitative aspects of the ARDC personnel picture.

> *"We are engaged today in a technological war of time, and our capability to maintain a superior force . . . depends upon our determination and ability to take maximum advantage of today's rapid rate of scientific progress."*

AMONG the recent past accomplishments and present programs of ARDC and its personnel are:

1. The X-2 which was flown up to 2,060 m.p.h. and an altitude of 126,000 feet, the highest and fastest that man had flown before the X-15 flights.

2. The F-106 which set the world speed record of 1,525 m.p.h. in December 1959.

3. The B-58, a supersonic intercontinental bomber capable of speeds beyond 1,300 m.p.h.

4. The Thor intermediate-range ballistic missile with a range of 1,500 nautical miles which has gone into operational use in the United Kingdom.

5. The Atlas, intercontinental ballistic missile with a range of 5,500 miles which went into operational status in late 1959.

6. The Titan, also a 5,500-mile ICBM now in the flight-test stage.

7. The Minuteman, a second-generation ICBM of the solid-propellant type which will be much smaller and cheaper than the Atlas or Titan.

8. The Discoverer satellite which has been most valuable in developing techniques and equipment to launch and place satellites in orbit, to stabilize them in flight, and to obtain biomedical information essential to developing the future capabilities of man in space.

9. The Midas, a military satellite which will detect the launch of enemy ballistic missiles as they leave the earth's atmosphere by detecting the heat radiated by their rocket engines.

10. The X-15, a research vehicle leading to man-in-space programs of the future, which will carry man to speeds of over 4,000 miles an hour and to altitudes ranging from 50 to 100 miles.

11. The Dyna-Soar, which is designed to place a manned glider in flight around the earth.

Research and development in the aerospace age is big business and requires astute management to assure the greatest return from the many dollars invested.

In this fiscal year 1960, the total dollars invested are about 3 billion. About $386 million of this amount is required for command operations—in other words, the cost to keep the plant running with pay of civilian personnel, fuel, electricity, and other overhead costs. An additional $1,052 million, approximately, supports the research and development operation—the greater part of this money going on contract to the universities, research groups, and industrial companies of our country. Thus, a total of about $1 billion, $438 million is charged directly to the Air Force research and development budget.

SUPPLEMENTING this amount are production and procurement funds which provide aircraft, missiles, and other equipment to support the development-testing program. These accounts total about $1 billion, $560 million—thus bringing the grand total of money made available for research and development to about $2 billion, $998 million for fiscal year 1960.

In terms of real estate, such as airfields, missile test sites, fixed facilities, and laboratory equipment, an investment of about $2 billion has been accumulated and modernized over the years.

To put the Air Research and Development Command in perspective, it is the focal point for essentially all research and development in the Air Force to serve the needs of the operating commands. In carrying out its mission, it works closely with the other military services, such as the Army and Navy, and with other Government agencies like the National Aeronautics and Space Administration, the Atomic Energy Commission, and the Department of Commerce.

This, then, is the Air Research and Development Command—an organization working in the present but looking to the future. Its objective is to develop advanced systems on a timely and economical basis in close coordination with all components of the Department of Defense and the United States Government which are engaged in research and development.

Soviet Metrology

Premier Khrushchev demands improved standards and a dynamic program

IN an address to the 21st Congress of the Communist Party of the Soviet Union on the "Development of the National Economy of the U.S.S.R. in 1959-1965," Nikita Khrushchev demanded increased efforts and results in the fields of standards and metrology. The Communists plan to produce 2½ times more control equipment in 1965 than in 1958 and a comparable increase in measuring equipment. The following is quoted from the address:

"THE provision of the necessary basis for the increase in the amount of measuring equipment used in industry is the task of the scientific research institutions, design bureaus, and the entire instrument-making industry.

"The scientific work of the metrological institutes grows from year to year. In 1958, prototypes of new measuring devices, plants and methods were developed.

"The schedule of the scientific research institutions of the Commission of Standards, Measures and Measuring Devices for 1959-1965 includes 101 large scientific research problems. As a result of their solution the national economy will receive several hundreds of measures, measuring devices, plants, and methods.

"A considerable amount of development work is planned in the field of thermal, optical, radioelectrical, magnetic, and acoustic measurements, and also in the fields of measuring superhigh pressures and ionizing radiation (electron, X-ray, beta and gamma radiation). Standard and master instruments will be developed with the object of expanding the range and increasing the accuracy of measurements in these fields and also in the fields of force, angular velocity, acceleration, and measurements of short periods of time.

"The lagging behind of metrological science and engineering in the fields of gas analysis, the measurement of large discharges of liquids and gases and temperatures close to absolute zero, and also in the development of theoretical problems of metrology must be overcome.

"In the Seven-Year Plan of scientific research work in the field of metrology it is intended to devote much attention to the problems of the automation of measurement and control of finished components and articles and their automatic inspection during the manufacturing process.

"In order to provide the basis for the development of automation it is also necessary to carry out the standardization of types, parameter ranges, dimensions of connections, technical requirements, and the methods of testing of the principal means of automatic control and regulation.

"The automation of measuring processes is one of the most effective means of increasing the productivity of labor in inspection work. However, until now the automation of processes in the inspection of measures and devices has been extremely slow. For the Seven-Year period ahead of us a considerable amount of work has been scheduled in this direction. Methods of automatically recording the indications of precision balances must be developed and the automation of some linear, heat, and electrical measurements carried out, etc.

"One of the most important conditions for the development of the engineering industry is the design and construction of machines and devices based on the utilization of the latest achievements and discoveries of science and technology and especially of electronics, superconductivity, ultrasonics, radioactive isotopes, semiconductors, nuclear energy, etc. This leads to the need for utilizing the latest achievements of science and technology in the development of measuring techniques and the construction of the most up-to-date measuring devices and plants. Much work will be carried out in this direction in the next few years—the development of new standards for magnetic units by using the phenomena occurring inside the atom, by using semiconductors for temperature measurements, and by using radioactive radiation for linear and temperature measurements, etc.

"Problems of the utmost importance must be solved in the standardization of measuring methods. They include above all the standardization of electronic measuring devices for measuring ionizing radiation, equipment for spectral, photometrical, and colorimetric analyses. The standardization of equipment for linear, mechanical, heat and electrical measurements must be continued."

FROM the above, it is clear that the Soviet industrial planners understand fully the importance of maintaining an adequate standards service and the necessity of having precision measuring equipment relating to these standards available for the necessary inspection throughout their industrial complex. They particularly stress the importance of automatic equipment.

It is to be hoped that the United States national program in standards and the application of modern metrology to our production will continue to make sufficient progress to maintain our present lead in this vital field.

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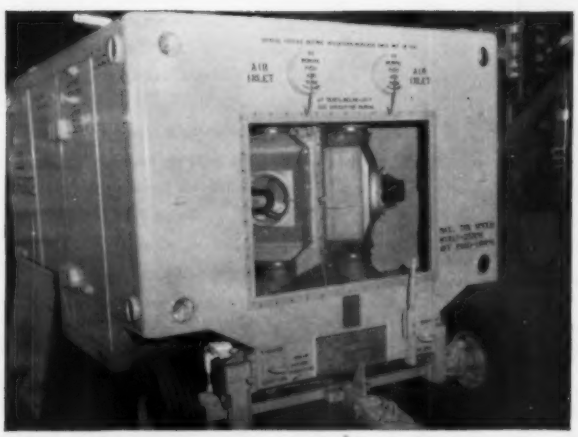

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U. S. Army Photograph

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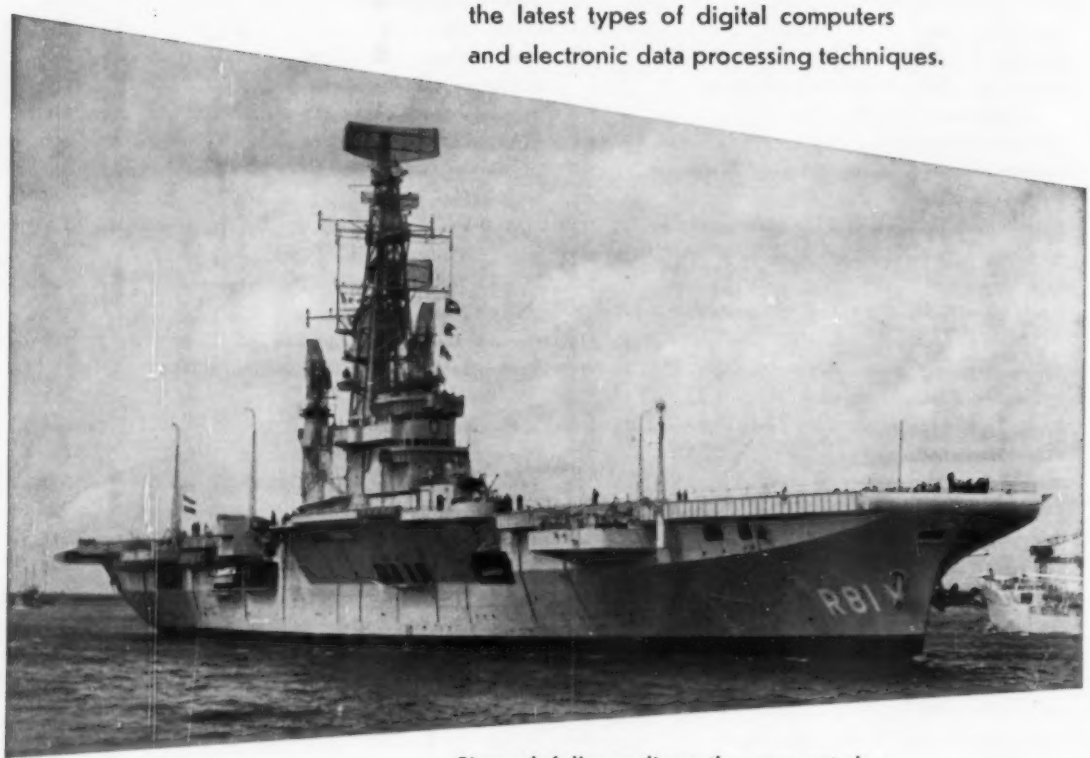

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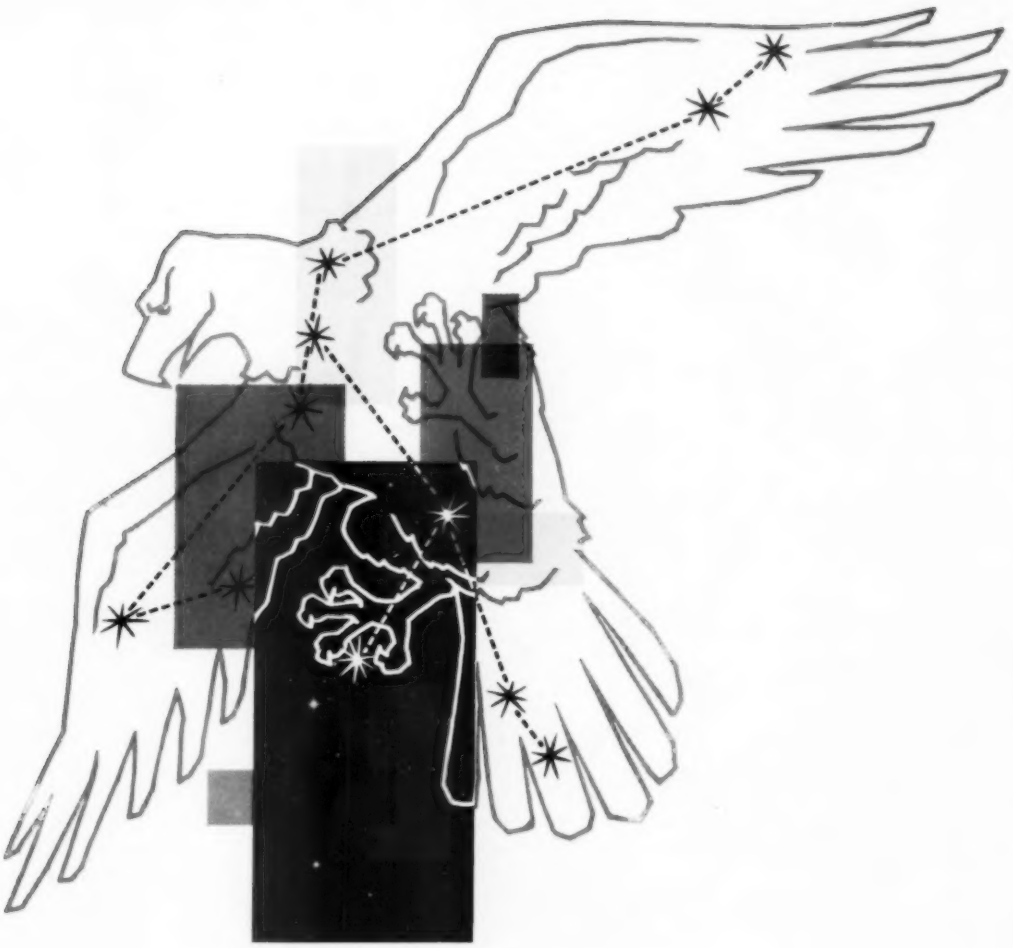

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